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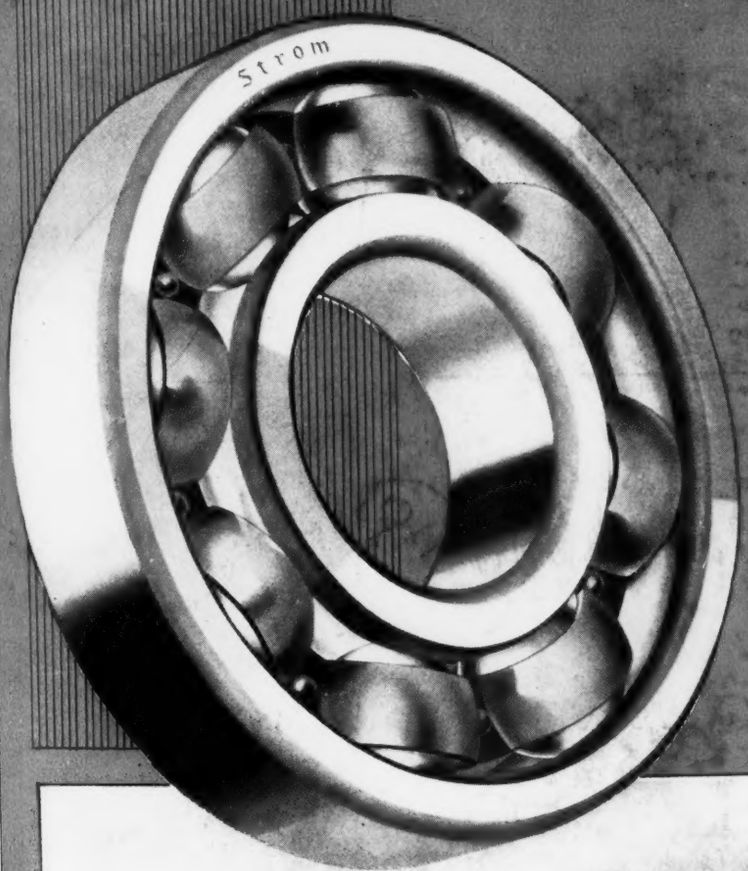

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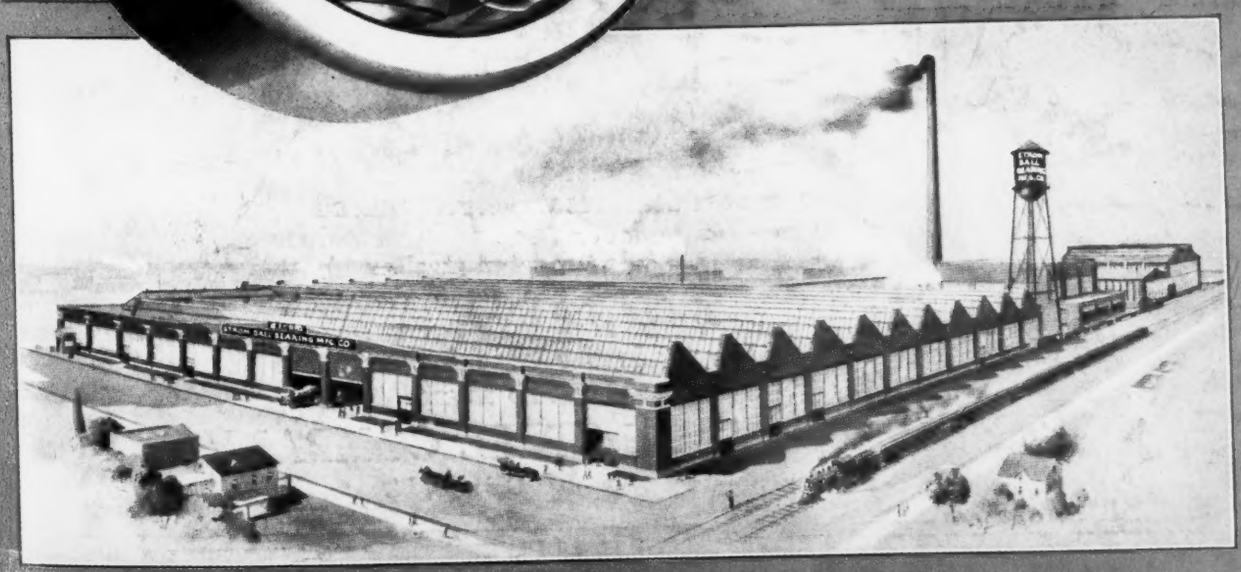

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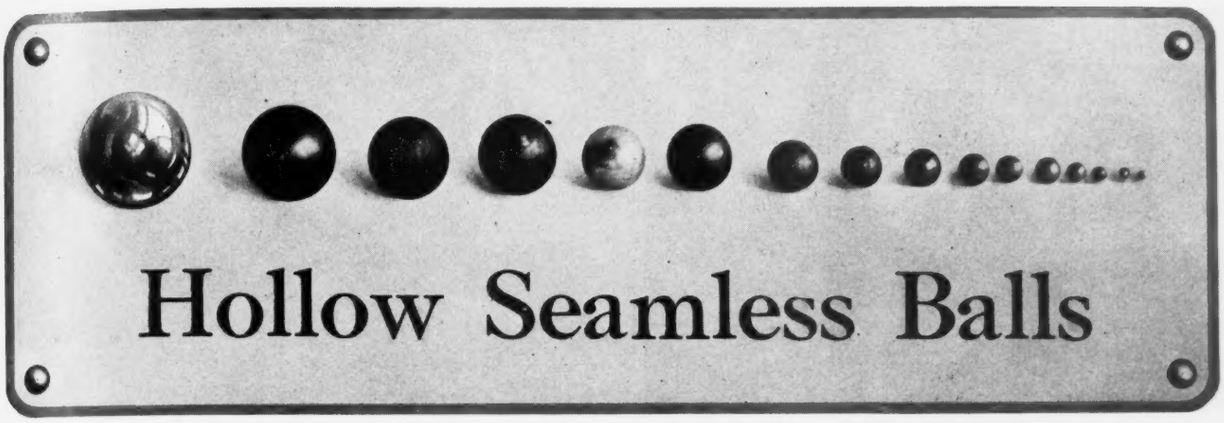


Hollow Seamless Balls

How One-piece Seamless Balls are made by a Process Developed to Insure Accuracy of Form and Balance, Combined with Lightness and Strength

By FRANKLIN D. JONES

IS it possible to produce from a single piece of sheet metal, a hollow, plugless, seamless ball that is accurate as to diameter, roundness, wall thickness, and balance? Balls of this kind were required in large quantities for a special check-valve application; it was also realized that such balls could be employed to advantage in connection with check-valves of various types, as well as for pump valves, steam traps, floats, anti-friction bearings, and numerous other applications. The mechanical and manufacturing problems involved the production on a commercial basis of hollow seamless balls having an accuracy, strength, and balance required to meet actual service conditions. After much experimental work, a process has been developed by the Hollow Ball Co., Inc., Baltimore, Md., for making seamless hollow balls that meet the exacting requirements previously mentioned. Before considering the details of this unusual process, the product itself will be referred to briefly in order to show clearly the relation between its important features and the means of production.

These hollow seamless balls may be made from various metals, such as brass, bronze, monel metal, white metal, nickel, silver, and steel. The diameters at present range from ¼ inch up to 3 inches, although this does not represent the maximum range, which will soon be increased by the addition of larger sizes. The outstanding features and general characteristics of these hollow balls may be summarized as follows: They are made from a single piece of metal and without seam, joint, or plug; the raw material may be either in the form of flat stock or a short seamless tube section, depending upon the size of the ball, as explained later; the wall thickness is uniform and is proportioned according to the ball diameter in order to combine maximum strength with minimum weight; the form is spherical within the limits of accuracy required for different commercial applications; the uniformity of the wall thickness insures an accurately balanced ball; the manufacturing process that shapes the metal while cold involves a rolling or spinning under pressure which improves the physical properties of the metal. Because of these unusual properties, hollow seamless balls have important practical advantages.

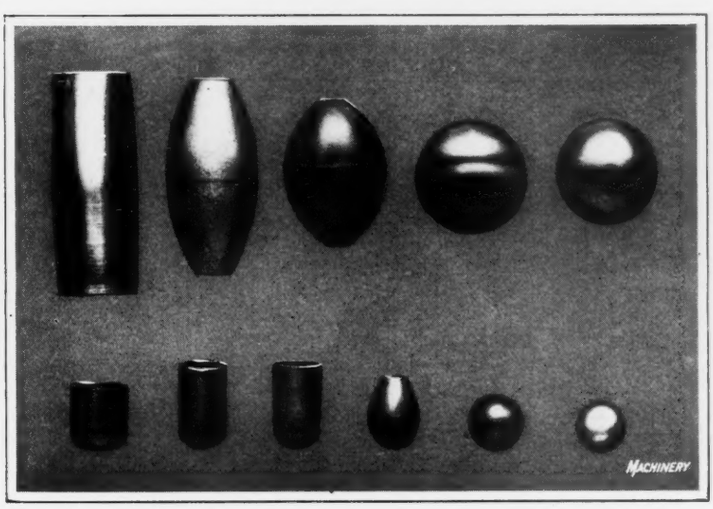


Fig. 1. Evolution of Hollow Seamless Balls as made from Tube Section (Upper View), and from Flat Stock (Lower View)

As is well known, balls of the hollow type have been used quite generally for many years, especially in check-valves, pump valves, etc., and several different methods of producing them have been employed. One method consists in using a hollow casting having a cored interior and a core hole which is plugged prior to machining the outside. Another method involves drawing two hemispherical sections from sheet stock and joining them together either by soldering, welding or by the use of a threaded joint. A third process consists in building up a hollow ball by the electrolytic method, in which case a plug must be used to fill the opening left on one side, the same as in hollow balls made from castings. The process of making seamless hollow balls to be described differs radically from methods previously employed, both in regard to the manufacturing procedure and the results obtained.

Two general methods are employed in making hollow seamless balls, as far as the preliminary stages of the work are concerned. For balls up to ¾ inch in diameter, sheet stock in strip form is used as the raw material; for larger sizes, up to the present maximum of 3 inches, seamless tubing is employed.

In producing these balls by either method, maximum lightness consistent with strength is obtained by regulating the wall thickness in proportion to the diameter. It is claimed that a wall thickness of approximately 10 per cent represents the ideal condition, and that a greater wall thickness

Fig. 2. Double-action Press used for blanking and drawing Cups from Strip Stock

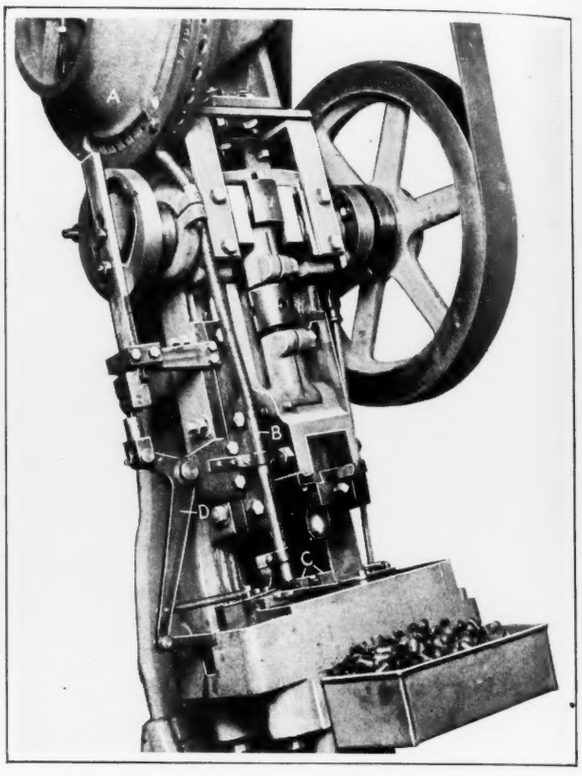


Fig. 3. Automatic Press for pointing Drawn Cups, preparatory to rounding

would merely increase the weight without adding to the strength. The contention is that the capacity or safe load of a hollow ball increases appreciably with increasing wall thickness up to a certain critical value. As the thickness approaches this critical value, the increase in capacity becomes less and less in proportion to the wall thickness, and beyond the critical point any increase in wall thickness merely increases the bulk and weight without adding to the strength.

It is evident, then, that the thickness of stock from which balls of a given size are to be made is an important point, and the measurement of the stock to see that it is within the close thickness limits required is the first step in the manufacturing process. This micrometer measurement is followed by an inspection to determine the degree of "temper" or hardness, the Rockwell test being employed for this purpose. An important advantage claimed for the use of either thin cold-rolled strips or of seamless tubing as a raw material is that hidden internal defects are less likely to exist than in heavier materials such as would be used in making solid balls.

After the stock has passed the test for thickness and physical properties, it undergoes a series of press and die operations which are preliminary to the more special operations to follow. The general procedure in making the smaller balls from flat stock will be described first, the various operations being dealt with in successive order.

The evolution of a hollow seamless ball as made from flat stock is illustrated by the lower half of Fig. 1. The first press operation is that of blanking and drawing a cup. This is done on a double-action press (Fig. 2), equipped with a blanking and compound drawing die. The latter consists of two dies located one above the other in such a way that the first drawing operation is immediately followed by a second reduction as the cup is pushed through the lower die by the punch, which is of the right size for the lower section. The sectional view *A*, Fig. 4, illustrates the general arrangement. A standard press is used for this operation, and the strip stock is automatically fed from a coil through the die by a feeding mechanism of the roll type.

The cups are next redrawn to the shape indicated at *B*. The presses used for this operation are of duplex design (see Fig. 5) and are equipped with an automatic feed of the dial form. Cups for balls of medium sizes have flats formed on the bottom so that the cups will stand upright upon the plain disk of the dial-feeding mechanism. As this disk revolves it conveys the shells between guides *A* which gradually converge so that there is space for but one shell at a time to emerge from the point opposite the punch. As each successive shell moves outward, a push-finger *B*, properly timed with the movements of the punch, transfers the shell to the die where the reduction takes place. The redrawing of smaller cups which have rounded bottoms and will not readily stand upright upon a plain disk, is done on presses equipped with dials containing holes to receive the shells, the dial indexing from one hole to the next for each stroke of the punch.

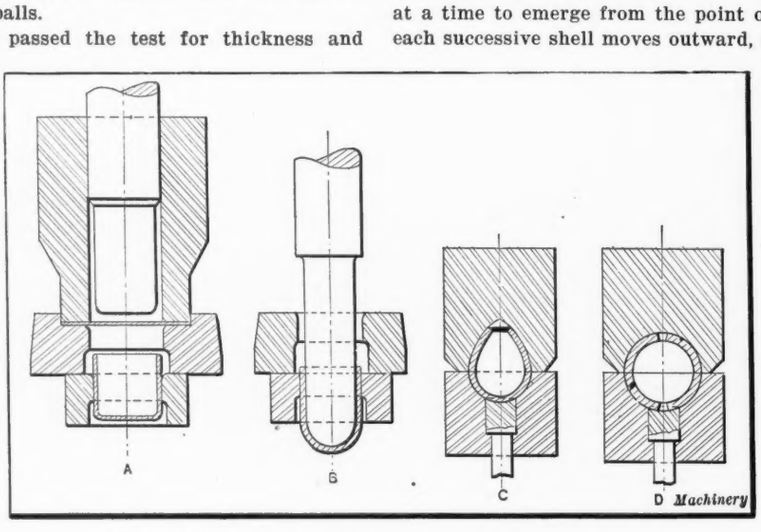


Fig. 4. Sequence of Press Operations in making Balls from Flat Stock

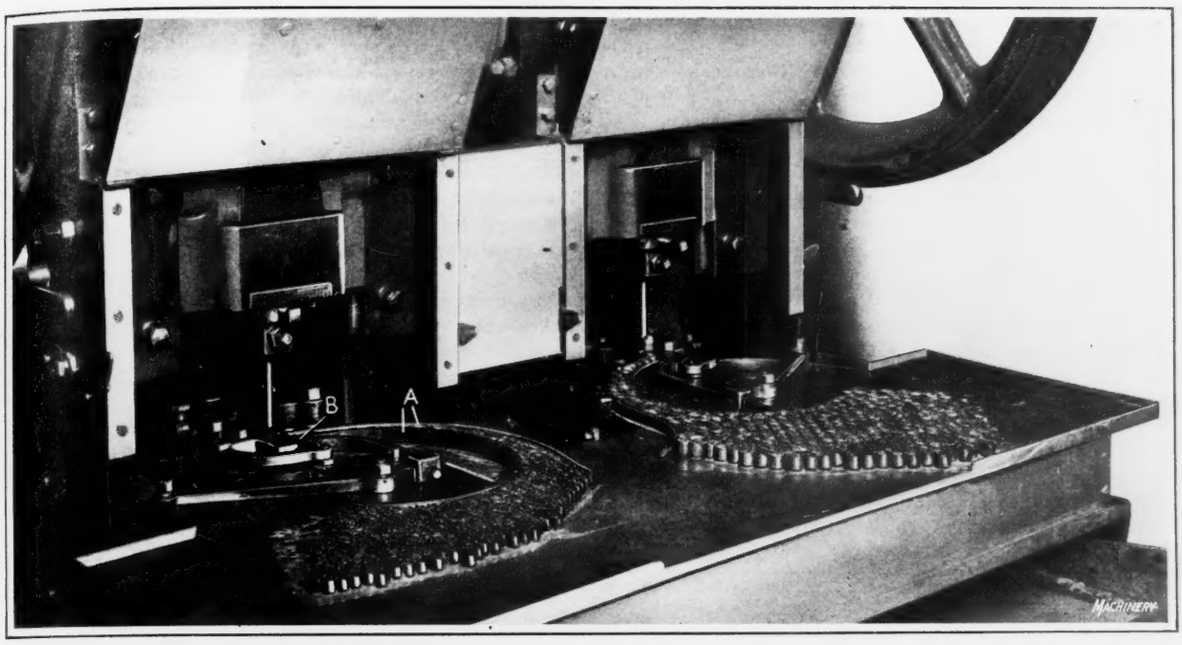


Fig. 5. Duplex Redrawing Press working simultaneously on Cups of Two Sizes

Trimming the Drawn Cups and Annealing

The next operation is that of trimming the open ends of the drawn cups in order to remove all defective metal and produce smooth edges, as well as shells of the correct length. The shell length is held within a limit of 0.001 inch to provide the right amount of stock for forming a hollow ball. The trimming is done on special machines, one of the larger sizes being illustrated in Fig. 6. The operation is entirely automatic, the shells passing from the rotary magazine feeding mechanism *A* at the top through a tube *B* to the transfer arm *C*. This arm swings from a vertical to the horizontal position shown, with a shell in place so that plunger *D* can push the shell against a stop in the collet chuck at the left. As soon as the shell is gripped by the chuck, a side arm *E* swings in, thus feeding the trimming tool across the edge. The trimmed shell is then ejected and another is immediately transferred from the tube as described. If a shell should enter the transfer arm in the wrong position, the closed end, instead of the open end, would be encountered by plunger *D*, which would thus be prevented from entering the shell, causing the latter to drop down before reaching the chuck.

Before proceeding with the press operations, the shells must be annealed to restore the drawing qualities of the metal. This annealing is done in gas-fired furnaces of the rotary type (see Fig. 7). The operation is entirely automatic, as the temperature is automatically regulated and the shells pass through the furnace and into the quenching tank at the proper rate for annealing. A temperature of 800 to 1100 degrees is maintained, depending upon the size of the shells and the material used. At the left-hand side of the illustration may be seen the pyrometer equipment which automatically controls the annealing temperature.

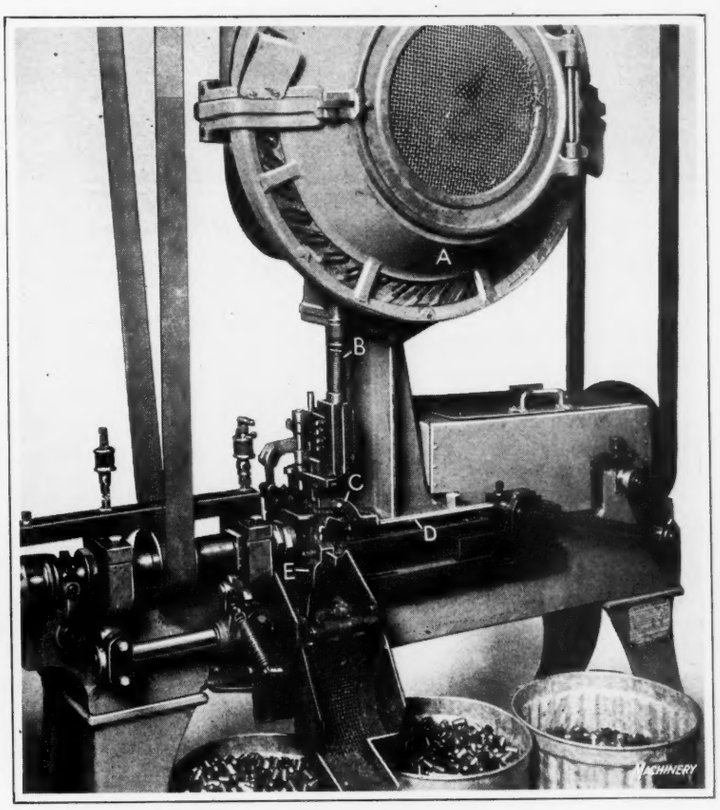


Fig. 6. Automatic Machine for trimming Edges of Drawn Cups

Pointing and Rounding the Drawn Cups

Annealing is followed by two additional press operations. These are illustrated by the diagrams *C* and *D*, Fig. 4. Operation *C* is known as "pointing," and it is performed by using a punch and die of the form shown. The press employed is equipped with a magazine feed of the rotary type (see Fig. 3). The magazine *A* is located at the top of the press, and as the shells descend through the tube *B*, they are transferred in unison with the movements of the punch, by flexible transfer fingers at *C*, which spread apart as the punch descends about the shell. Describing the action somewhat more in detail, the lowest shell in the feed-tube falls into a pocket formed by the transfer fingers. The transferring movement, which is cam actuated through the bellcrank *D*, occurs while the punch is moving through the upper part of its stroke. When the shell is in line with the die, the punch moves down to the position shown at *C*, Fig. 4, and the upper part of the confined shell is forced into the same shape as the cavity in the punch.

The rounding operation illustrated at *D* is similar in principle to the pointing, the shell

being given approximately a spherical form by using a punch and die of corresponding shape. The flat disk representing the first operation has now been changed to a form resembling quite closely a hollow ball. It will be noted, however, that there is a small opening at one point, and right here we have the real problem in hollow ball manufacture. How is this opening to be closed completely and is it possible at the same time to produce an accurate ball having a uniform wall thickness throughout? This interesting part of the process will now be explained.

Closing Operation for Forming Seamless Hollow Balls

After a second annealing operation in the automatically controlled furnace, the closing of the small aperture left by the rounding dies, and the rolling of the ball to size (plus a small grinding allowance) and to the required wall thickness, is done by means of special machines representing the most important part of the entire manufacturing process. One of these machines is shown in Fig. 8. The closing operation consists, briefly, in rolling the balls between two circular plates. These plates, which are located at *A* and *B*, each contain grooves of corresponding shape and diameter, there being a single groove in plates used for very large balls and as many as five concentric grooves in plates used for the smaller sizes. The grooves in each plate are directly opposite thus forming circular channels through which the balls roll. Plate *A* is stationary, whereas its mating plate *B* revolves at an average speed of about 450 feet per minute. The distance between the plates may be varied by turning the pilot wheel *C*, which, through a large screw, provides means of gradually increasing the pressure on the balls during the closing operation.

The balls to be closed are dumped into a hopper *D*. This hopper is equipped at the inclined bottom with a rotating disk having notches in its edge. As the balls drop into these notches they are carried around to the top of the magazine where they drop in rapid succession into tube *E* leading to the inner groove of the rolling plates, assuming that a multi-grooved plate is being used. After a given ball makes one passage around the inner groove, it is intercepted and rolls through an opening or passageway in a block at *F*, forming a bridge which leads to the next outer groove in the series; after passing around the second groove, the ball is again intercepted by a similar opening in the block, thus passing to the third groove, and so on until the outer groove of the series is reached. Finally, the ball enters tube *G* and is pushed up by a succession of balls following until it again enters the hopper *D*. This cycle is then repeated until the balls have been rolled to the diameter desired. Inasmuch as the balls are continually passing from the rolling plates to the hopper, it is a simple matter to check the diameter at any time.

The plates used for this closing operation must be accurate as to form and have a highly polished surface. Fig. 9 shows how the grooves are ground, the plates in this instance having three concentric grooves. After grinding, all wheel scratches are removed by a lapping operation which is performed in a lathe equipped with a motor-driven lead-lap which is shaped to suit the groove section. This lap rotates across the groove as the plate revolves and imparts to the surface a perfectly smooth finish.

Shape of the Grooves and Action of Balls while being Rolled

As may have been inferred, the secret of this closing operation lies in the cross-sectional shape of the grooves in the rolling plates. After much experimenting, it was found that the exacting requirements of this part of the process were possible of attainment by employing a groove having straight sides which merge into a bottom section of approximately circular form. The included angle between the sides is 60 degrees, and the bottom is of special curvature, being formed by a series of three arcs which merge into one another. With this shape, pressure against the ball, especially at the beginning of the closing operation, is largely localized at four points. As the ball rolls about the circular track, its position changes constantly, so that all parts of the surface are subjected to the direct application of pressure.

The movement of a ball is the result of three simple motions combined: First, owing to the relative motion of the two plates, the ball as it rolls along the groove tends to turn about an axis perpendicular to the axis of rotation of the plate; second, owing to the circular form of the plates, the speed of the points of contact further removed from the axis of rotation is greater than that of the other points of contact, which tends to impart to the ball a spinning action about an axis parallel to the axis of rotation of the plate; third, as the pressure and area of contact in-

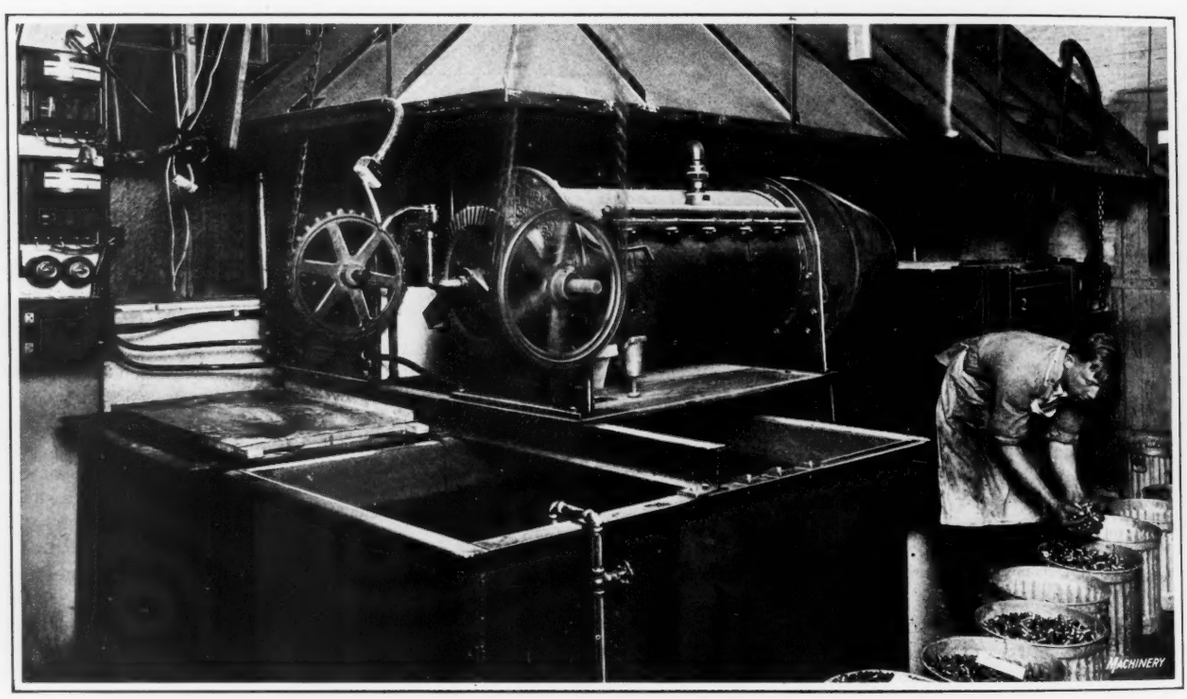


Fig. 7. Automatically Regulated Furnaces for annealing Balls after Certain Press Operations

crease, a gyrational movement is generated about an axis which is tangent to the circle described by the center of the ball. The natural result of this combined motion is that all points of the ball are successively being brought into contact with the grooves, thus insuring a uniform working of the metal.

During the closing process, the pressure is increased gradually by the pilot wheel shown in Fig. 8, and a heavy oil is used to prevent trouble from abrasion. A ball at first rests high on the grooves contacting at four points, as previously mentioned. Under gradually increasing pressure these points of contact recede lower and lower until at the completion of the operation there is a full line contact between the ball and the bottom of the grooves. The rolling time is about three minutes, and the number of balls rolled at one time depends upon their size. Thus, the plates for small balls, which contain five concentric grooves, hold a great many more balls at a time than those containing, say, only two or three grooves, as for the larger sizes. The object, therefore, in employing a series of concentric grooves, as for the smaller sizes of balls, is merely to increase the capacity of the machine. The plates used for the ½-inch size have a capacity for rolling approximately three hundred balls simultaneously.

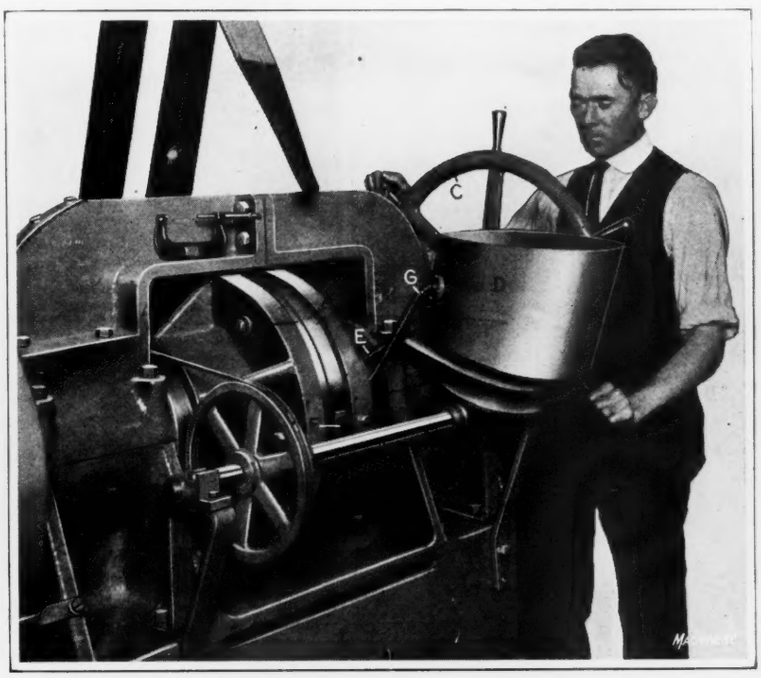


Fig. 8. Rolling Machine used for Closing Operation and for producing Balls of the Required Diameter and Wall Thickness

The uniform wall thickness obtained by this rolling process is one of the points of particular interest. Before the rolling or closing operation, there is some variation in thickness, especially around the "pole" or small opening. During the rolling operation, any such irregularity, either adjacent to the opening or elsewhere, is gradually eliminated, as the volume or diameter of the ball is decreased. This contraction of the ball is due to the gradual increase in pressure and to the fact that the ball when entering the groove has a radius larger than the bottom of the groove. A double effect is the result: first, the excess material goes into and thickens the wall of the shell; second, some of the excess material is forced to flow into the aperture, thus closing it. The uniformity of wall thickness is obtained automatically, and apparently is due to a flowing of the metal toward any low spots which naturally would offer the least resistance to such a movement. Incidentally, a ½-inch ball is reduced in diameter about 0.045 inch by the closing operation, and the wall thickness at the same time is increased about 0.020 inch. While these figures vary for other sizes, the ones given illustrate in a general way the change in dimensions due to rolling or closing.

What becomes of the opening, and is it entirely eliminated during this closing operation? An examination of a section taken through the closed part shows what is apparently a homogeneous wall of metal. The contention is that the combination of movements during rolling, in conjunction with the proper application of pressure due to the shape of the grooves in the plates, entirely eliminates the opening by what has been defined as a "mechanical knitting" of the surrounding fibers.

The final operations include grinding and burnishing to give the balls the accuracy and finish required. Special machines are used for grinding, and the burnishing is done in tumbling barrels of the ordinary inclined type.

Tube Process as Applied to Larger Balls

Hollow balls ranging in diameter from ¾ inch up to the maximum size are made from short sections of seamless tubing, instead of using flat stock as for the smaller diameters. The successive stages in the tube process are illustrated by the upper half of Fig. 1. Cylindrical tubing is used as raw material. A tube section is first turned on the outside to a slight curvature, a commercial type of "automatic" being used for this curving operation and for cutting off the tube. By giving the outside of the tube a slight curvature and thus removing some of the metal from the outer ends, the tube is prevented from "telescoping" when it is subjected to the "pointing" and "ovaling" operations which follow, as represented by the illustration. In other words, if this excess metal were not removed, the pressure required for the operations just mentioned would cause buckling of the metal of the tube; furthermore, there would be an excess of metal at the ends.

The number of die operations required varies from three to five, the number increasing for larger balls. Fig. 2 shows the evolution of a ball requiring a series of three press operations. The tube method leaves two openings in the ball after the rounding operation, instead of one, as when flat stock is used. While it would be possible to make the larger balls from flat stock, the use of a tube section with its double opening after rounding makes it possible to obtain a uniform wall thickness more readily in the closing operation. The procedure in closing these apertures and the other finishing operations are the same as those previously described.

Inspection

In the inspection department, the hollow balls are graded automatically by the special machines shown in Fig. 10. The balls are dumped into a hopper, as at *A*, from which they are transferred one at a time by a rotating carrier to an opening at the upper ends of the gaging plates *B*. The ball then rolls down between these inclined gaging plates. Beneath the plates there are six tubes leading to six separate drawers in the cabinet below. Each tube receives balls of a different size. The first tube represents the minimum size and the last one the maximum size. The plates are 0.0006 inch farther apart at the sixth tube than at the first tube, so that each tube in the series represents a variation of 0.0001 inch. Balls that are under size drop between the plates before reaching the first tube, whereas the over-size balls roll past the last tube. The balls are given a final inspection to safeguard against any slight defects that might occur without previous detection in connection with a manufacturing process which is automatic to such a large extent.

General Application of Seamless Hollow Balls

At the present time the production of these hollow balls is confined to non-ferrous metals, such as brass, monel metal, aluminum, etc. However, hollow seamless steel balls may be manufactured for bearings or for other purposes, but the possibilities in this direction cannot be dealt with at the present time. The non-ferrous balls are employed in connection with valves for deep well and other classes of pumps, for air compressors, fire extinguishers, check-valves for radiators, pneumatic devices, injectors, pressure cookers, or wherever a light, strong, seamless, balanced, leak-proof ball is required to give the best results. Monel metal balls are being used to advantage for many applications where acids or dampness would injure other metals.

The advantages of the spherical form of valve in certain classes of pump work and for various other purposes are well known. It is also evident that lack of balance and unnecessary weight are serious defects. Balls which combine strength with lightness and accuracy of balance obviously are superior for such work. A well balanced ball, whether used as a pump valve, check-valve or in a similar manner, is sure to change its position constantly, thus pre venting localized wear, whereas an unbalanced ball tends to remain in one position. Shocks are also greatly reduced by using lighter balls, and the life of both valve and seat is increased accordingly. Another advantage claimed for these hollow balls is that they possess a certain degree of resiliency which is of considerable practical value in connection with valves operating under high pressures.

* * *

According to a statement credited to Dr. Schlesinger of Berlin, Germany, who is in charge of the machine tool laboratory maintained by the German Machine Tool Builders' Association, the association spends $40,000 (in gold) annually on research. A regular staff is employed by this laboratory, and in addition to the paid staff there are a number of graduate engineers working for doctors' degrees who give their full time to this work. The association has over 400 members.

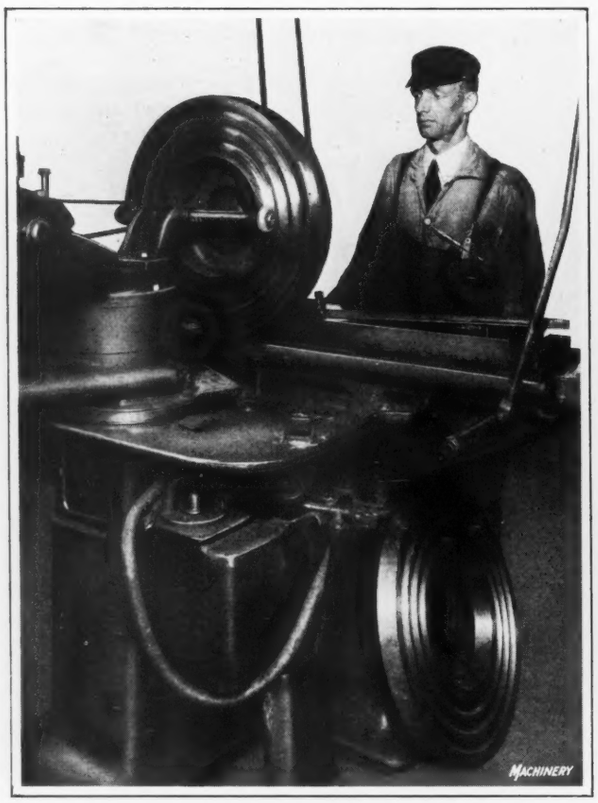


Fig. 9. Grinding the Grooves in One of the Plates used in a Rolling Machine

A LEATHER REPAIR BEARING

By EDWARD A. GUNN

The writer recently made a successful emergency repair for an automobilist which may be of interest to some of the readers of MACHINERY. An automobile which had been driven from Newark, N. J., to New Haven, Conn., was found to have the roller bearing in the wheel broken so that the wheel was running on the hub, no part of the bearing or retainer being left in the hub. As a substitute for the roller bearing the writer packed the hub of the wheel solid in the center and out to the retaining washers with leather from a piece of leather belting 1 inch wide by ¼ inch thick. The leather bushing thus provided was packed well with oil and grease. This improvised bearing gave no trouble and was found to be in good condition at the end of the 103-mile return trip. It may be of interest to mention here that leather belting also makes a good emergency replacement for babbitt or bronze connecting-rod bushings when the latter are burned out on the road. The same method can be employed in repairing bearings for small emery wheels.

Fig. 10. Grading Machines which automatically sort the Finished Balls

* * *

At the recent meeting of the Cleveland Section of the Society of Automotive Engineers, T. L. Litle, Jr., Chief Engineer of the Lincoln Division of the Ford Motor Co., presented strong arguments against the almost universal practice of announcing new passenger car models once a year. Mr. Litle stated that this practice has had a retarding influence on a normal, healthy, and sound engineering development. The hustle in engineering and manufacturing departments necessary to put out a new model each year leaves little time for careful engineering research and tests. Engineers, according to Mr. Litle, are largely responsible for the persistence of the yearly model policy. They are the ones who often influence the management to adopt radical changes instead of perfecting and refining an existing product. Continual improvements can be made in the product without changing the design in such a way that the service on older cars is neglected.

The Machine Tool Situation in Europe*

By W. H. RASTALL, Chief of the Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.

THE position of the American machine tool manufacturer in the markets of England may be roughly outlined as follows: During recent years, British manufacturers of general service machine tools have brought out a large number of new machines representing new designs, revised designs, or, in some instances, copies of American designs, and the American manufacturer of these general service tools will find it more difficult to secure business in the British market than was the case some years ago. Some of the gentlemen with whom I consulted in England were of the opinion that it would be impossible to continue to export general service tools to the United Kingdom; others felt that the trade might continue, but would be on a restricted basis.

Again speaking in broad lines, the indications are that the American manufacturer of special manufacturing machines has as good an opportunity in the British markets as ever, and in view of the larger scale of operations —especially in the automotive industry—there is a better opportunity for the sale of the American product than there has ever been before—war booms excepted.

For both of these classes of equipment it is clear that if the American manufacturer wishes to continue his business in the British market he should, if possible, arrange for a higher type of salesmanship in those markets, as the only way to sell the special manufacturing tools is by means of salesmen who understand fully the applications of these tools to modern factory production. Similarly, for the general service tools a better grade of salesmanship is necessary in order to overcome the keen competition that has recently developed in the United Kingdom. Probably the time has not yet come when it would be good business to make determined efforts along these lines, as the United Kingdom is still experiencing a serious depression. Generally speaking, industry there is on a restricted basis, and the unemployment situation is still very serious.

From what I could learn while in England, there is reason to believe that the machine tool industry there is operating at about 60 per cent of capacity, and 80 per cent of this production is exported. These figures indicate that the consumption of machine tools in the United Kingdom is still very small, but they also indicate that the British manufacturer is enjoying a larger proportion of the machine tool trade with foreign countries than are the American manufacturers.

Conditions in Germany

Unoccupied Germany is exporting about half the volume of machinery that old Germany exported in 1913, and, while reports from some sources have suggested that the machinery trade of the world would pass into German hands, the best information so far received indicates that this is in no sense true. The German position in the machinery markets of the world today is far below the position occupied previous to the war.

Similarly, on the score of price, very interesting situations have developed. From certain sources in Belgium and Holland that seem dependable, claims have been made that German quotations on machine tools are still from one-fourth to one-third the American price; in fact, it was added that these quotations applied to machinery that is to be newly built. Contrasting sharply with reports of this character, I was informed in Germany and certain other countries that German costs are now above the world market levels, and I have every reason to believe that this is true. It seems that we have now reached the point where German competition will be on a more genuine basis than has been the case during the period represented by the depreciation of the mark, and that German prices will be in line with, if not above, world market levels. However, in this connection it should be remembered that money is very "tight" in Germany, and that certain manufacturers still have in stock machinery that was produced at the time when the market was at its low levels. Manufacturers holding stocks of this character are frequently in financial distress and are exceedingly anxious to convert these stocks into liquid funds on almost any basis. For some months it seems probable that equipment sold from stock from Germany will be offered at very low prices and on most unusual terms.

On the other hand, the indications also are that in the future we will hear less about German manufacturers offering machinery on deferred terms. The tightness of the money market in Germany and the difficulties German manufacturers would experience in finding banking accommodations will prevent the sale of machinery by German manufacturers on terms that American manufacturers would consider unbusinesslike.

Apart from these generalizations, it is difficult to report on the machinery situation of Germany, owing to the rapid changes taking place there under the London Agreement, except that it can be stated that German industry and German business is suffering seriously because of the unstable conditions with which it is surrounded.

French Conditions are Improving

In France, conditions are far better. Industry there is active, and while certain lines of American machine tools are suffering from increased competition, because of new lines produced by French manufacturers, the high-grade American manufacturing machines are enjoying a greater demand than ever—war booms excepted. Several of the machine tool importers in Paris reported that for the current year their business was perhaps double that for the corresponding period of 1923.

In Central Europe conditions are improving, although they have been exceedingly bad there and are still far from satisfactory. Czecho-Slovakia is actively buying American machine tool equipment. On the other hand, the other countries of Central Europe still seem to be passing through the difficult conditions formerly experienced by Czecho-Slovakia, and little business should be expected from those countries until reconstruction has advanced further.

Conditions in Other Parts of Europe

From Italy and Spain there is little to report. Business is moving, but apparently on somewhat the same basis as has been the case during the recent past. On the whole, conditions in these countries seem to be working toward a better basis. Manufacturers here would be justified in giving these markets somewhat more careful attention than was the case a few months ago. Probably the distinctive feature of the existing situation is the need of more careful sales effort in all of these markets; for during recent years a comparatively new machine tool industry has been developed in England, as well as in Germany and France, and to some extent in certain other countries, and American machine tools can only be sold in these markets by means of more careful sales campaign.

*Abstract of address made before the National Machine Tool Builders' Association's convention at Lenox, Mass., October 9.

This raises the question as to representation, which has now become of greatly increased importance throughout Europe. For example, in Czecho-Slovakia the statement is very frequently made that the market should be approached only through a Czech. In these areas one finds countless evidences of exceedingly bitter nationalistic feeling. For example, in Prague one of the largest banks in the city has no sign-board whatever, because a local law requires that any signs exhibited shall be in the Czech language; and this German bank feels so bitterly about this that rather than show a Czech sign they show none. Obviously, to the extent that industry in Czecho-Slovakia is still in the hands of German interests, it will be necessary to approach these industries through German instead of Czech sales channels.

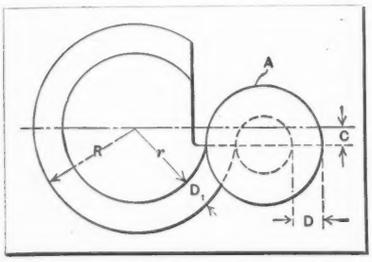
Similarly, in Poland the claim is constantly made that sales efforts should be made through a Pole, but to the extent that industry there still remains in German or Russian hands it would be impolitic to employ Poles as agents. In contrast with all this, in Vienna one will find machinery dealers who feel that they are prepared to represent American lines throughout all of these countries, and in Germany there are certain dealers who feel that they are prepared to represent American lines, not only in Germany, but in Czecho-Slovakia and Poland. Obviously, these claims cannot be reconciled, and, owing to the intense nationalistic feeling throughout Central Europe, it is clear that the matter is one of very great importance. American manufacturers should, therefore, reconsider the entire question of their representation throughout Central Europe and endeavor to market their products there through channels that will effectively reach as large a part of the industries in those countries as possible.

* * *

TURNING CIRCULAR FORMING TOOLS

By FRED J. BLUM

In the Data Sheet of May, 1924, MACHINERY, tables and formulas were given for use in machining circular forming tools having the cutting face offset with relation to the center of the tool. Tables and formulas of this kind are appreciated by many tool designers and toolmakers, but there are some skilled men who find it easier or preferable to avoid calculations whenever possible. The following method will meet with the approval of such men: Assuming that distance *C* in the accompanying illustration is ¼ inch and that it is required to turn a circular forming tool that will cut a step *D* of ¼ inch, it is simply necessary to set the point of the forming tool ¼ inch below the center of the lathe spindle and, using a dial indicator, feed the tool in 0.250 inch. In order to plane a forming tool to the required shape for cutting a step ¼ inch deep, when the angles at the point of the tool are 15 degrees, the shaper head is tilted over at an angle of 15 degrees and fed down a depth of 0.250 inch.



Circular Forming Tool with Cutting Face Offset

* * *

In our efforts toward quantity production we have grad ually neglected to provide for that body of trained men who will be needed to keep our country in the front ranks. Most corporations have been content to let somebody else train the skilled men they needed, and have not been very backward when it came to taking the fruits of someone else's labor. The war showed us our weakness vividly, although many far-seeing men had worked hard for a revival of apprenticeship training even before the war.—*John C. Spence, in a paper before the National Metal Trades' Association*

MANAGEMENT MUST DO ITS SHARE

In an address entitled "No Safe Short-cut to High Production," presented before the National Machine Tool Builders' Association at Lenox, Mass., October 9, Professor Henry H. Farquhar of Boston, Mass., pointed out that most of the failures in serious attempts to increase the production in manufacturing plants through the development of better methods of management are directly attributable to two main causes: (1) The installation of some kind of incentive or production payment scheme (piece-work, premium or "point" systems, task and bonus, or combinations of these) before the necessary foundation has been laid; and (2) the installation of methods not suited to the particular problems and conditions of the business in question.

"It is significant," said Professor Farquhar, "that those who have had the most to do with developing high-production management in the industries are generally agreed that of the production increases secured through thorough development of improved methods about 80 per cent has been effected by the *management* in its scientific study and adjustment of details in preparing the job before it is put into the hands of a workman at all; and only 20 per cent, or even less, on the average, can be secured through efforts on the part of the workmen themselves. The direct labor cost, furthermore, is in few industries as much as 40 per cent of the total cost of the product. An increase, then, of 20 per cent affecting a direct labor cost of 40 per cent of the total, gives only 8 per cent as the maximum total cost reduction which can be expected from labor itself. Even this 8 per cent may not be a permanent gain if the methods used in inducing it are such as to destroy the confidence and the morale of the workmen It is interesting in this connection to note that in really thorough developments of all functions of management, both the total and the direct labor cost reductions have often been two, three, or even four times as much as was contributed by the workmen alone.

"There is no permanent short-cut to increased production and decreased costs through speeding up the workman by any incentive plan. Even if management does succeed through such appeals in spurring the workmen to an increase in production and a decrease in cost, trouble is almost sure to come later on when the workmen realize that most of the burden has been passed to them.

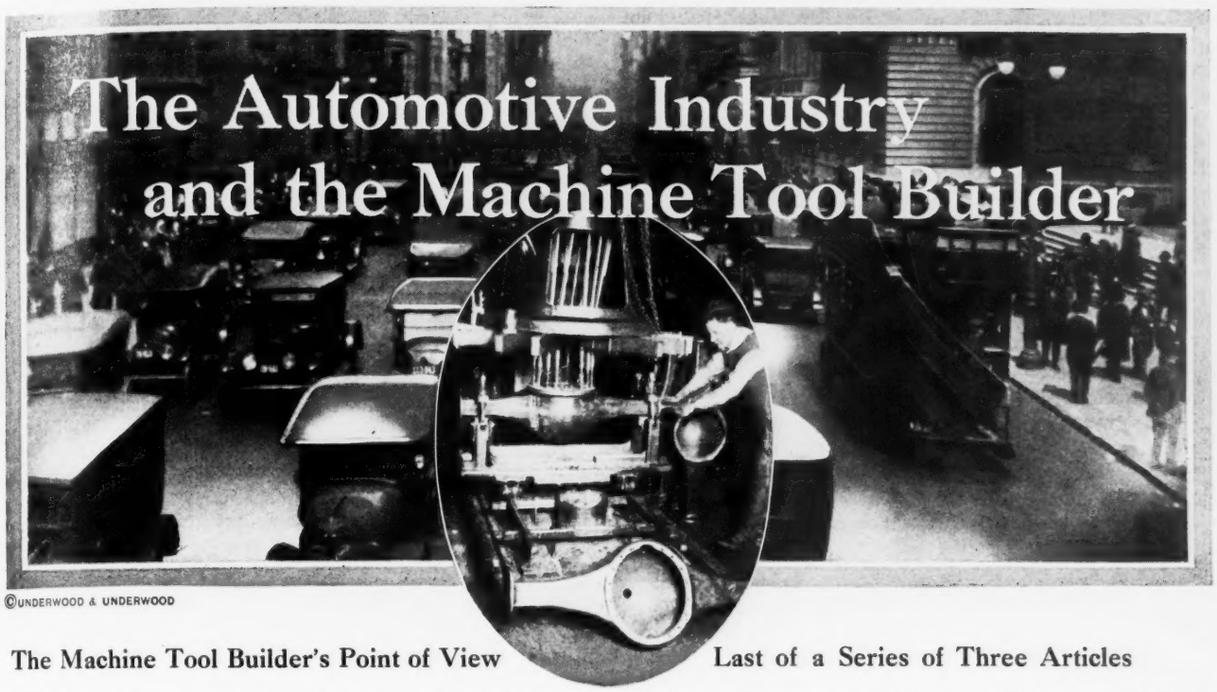
"The wiser managers of today believe that incentive payment instead of being of first importance should in nine cases out of ten be the last thing to tackle—if indeed it is necessary at all except as it helps to bring pressure on the management for the continuous discharge of its proper duties. The more forward looking managers recognize these facts and realize that until the management has seen to it that its own part is fully played—through careful standardization, effective planning, detailed scheduling, and all the rest—the incentive appeal will meet with only half-hearted or temporary response."

If management is to honestly assume its 80 per cent of the share of the work for obtaining increased production, there must first be a careful investigation and analysis of the particular problems of each plant; then suitable systems should be adopted for standardization, and for planning and preparation of the work, scheduling, dispatching, production, and inspection of the product. A definite organization scheme is necessary in order to produce the maximum amount of teamwork, and the problem centering about human relations in the industry must be carefully and comprehensively analyzed.

* * *

At a meeting of manufacturers of open-end wrenches recently held in New York, it was voted to ask the cooperation of the Division of Simplified Practice, Department of Commerce, in an effort to reduce the varieties of wrenches now made. The committee that will consider this matter includes A. S. Maxwell of J. H. Williams & Co., Buffalo, N. Y.; W. S. Swain of Billings & Spencer Co., Hartford, Conn., and L. J. Stoddard, secretary of the Lakeside Forge Co., Erie, Pa.

The Automotive Industry and the Machine Tool Builder



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The Machine Tool Builder's Point of View

Last of a Series of Three Articles

THE problems confronting the automotive industry in connection with machine tool equipment, as seen by production managers and equipment engineers in the automotive plants, were presented in the first and second articles of this series, in October and November MACHINERY. The present article gives the ideas of the machine tool builder pertaining to these problems. The information and opinions given have been obtained from a large number of the leading machine tool builders engaged in furnishing equipment to the automotive industry.

The Machine Tool Builder's Opportunities for Greater Service in the Automotive Field

In answer to the question, "What is the machine tool builder's greatest opportunity for effective service in the automotive industry at the present time?" many machine tool builders suggested that each manufacturer should make a more precise study of the production possibilities of his particular type of machine under the conditions existing in automobile plants, when the machine is installed as a unit in a complete production line. The need for more complete cooperation between the two industries in this direction was emphasized. Of recent years several machine tool builders have made it a practice to send their engineers and designers to the automobile plants so that they may study first-hand the conditions under which production is carried on and adapt their machines to the needs of this industry.

It would also be of considerable value to both industries if the engineers of the various automobile factories were to visit from time to time the machine tool building plants and observe the latest developments that may apply to automobile manufacturing requirements. Some automobile companies arrange to have their engineers visit different shops, but it would be of advantage if this were made a more general practice.

Standardization of Automobile Shop Practice

In the opinion of another machine tool builder, the greatest difficulty facing the machine tool industry is the greatly varying practice of different automobile manufacturers. Undoubtedly, most of these varied practices will some day become standardized; and one of the greatest services that the machine tool industry can render is to aid in determining upon the best method for each kind of work and in standardizing such methods as have been found to be the best. This service can be rendered only by keeping in intimate contact with the automobile industry, designing machine tools in close cooperation with representative automobile manufacturers, and concentrating on the standardization of those methods that give the best all-around results.

One machine tool builder points out that the need for automatic machine tool equipment is now greater than ever. This country is definitely committed to a policy of restricted immigration, and hence, if we are to maintain our standards of living, the automatic machine must be called upon to perform an ever-increasing service. It is not an easy mechanical problem to design and develop satisfactory automatic machines for many of the operations that have been performed in the past on machines requiring an operator for certain functions, but it is along this line that the machine tool builder will render his greatest service.

An important service can also be rendered by the continued development of machine tools so designed that multiple operations can be performed with a saving in equipment cost, floor space, and labor. These machines need not be entirely special, as they can be built so that they can be adapted for use by all manufacturers of automobiles and makers of automotive parts. One machine tool manufacturer has found that a number of machines of this type developed especially for the automobile field can be sold to advantage to other industries for similar classes of work.

Still another manufacturer points out that the automobile industry is best served by discouraging the use of too special single-purpose machines and advising more flexible equipment that will meet the requirements of frequent changes in car and engine design. "But the real service," he says, "can be rendered only by the automobile industry

One of the great difficulties of the machine tool industry in relation to the automotive industry is the greatly varying practice of different automobile shops. Most of these varied practices will doubtless some day become standardized, and one of the greatest services that the machine tool industry can render is by aiding in determining upon the best method for each kind of work and in standardizing such methods as are found to be the best. This service can be rendered only by close cooperation between the machine tool and the automobile industries, by studying the methods in the plants of representative automobile manufacturers, and by concentrating upon the standardization of those methods that have been found to give the best all-around results.

realizing the economic waste in the use of old, out-of-date machines. The machine tool builder who is permitted to replace this old equipment, now in use, with new machines, has a chance to render real service. Relatively few machines have been bought of late for replacement—nearly all the buying has been for increasing the capacity. Therefore, there are in almost every automobile shop a great many old machines still in use that have earned their purchase price many times over and are now being run at a loss, as compared with the saving in manufacturing costs and increased production possible with machines of improved and advanced design."

Reduction of Maintenance Costs—Free Service

The machine tools in automobile plants are subjected to very severe service. In many instances they run twenty-four hours a day, and when production is at its height the pressure on the maintenance department is so great that proper care is not given to the machines, and repairs must be hastily made. The inexperienced operators often employed know very little about the care of machine tools; hence one of the greatest problems of the machine tool builder in connection with equipment for automotive plants is to design such equipment so simply that little or no experience is required in its operation. It must also be made so rugged that it will stand up under the severe service; and furthermore, the design should permit repairs and replacements to be made quickly without taking the machine out of the production line for any considerable length of time. These different requirements necessitate a careful choice of materials and minute attention to details of design, to insure both strength and wearing qualities and convenience in assembling.

"We do not know of any industry," says one manufacturer, "that has given service to the user of its products as freely and generously as the machine tool industry. It is usually taken for granted by the purchaser of a machine that the price includes installation service and demonstration to the future operator. It is common practice when difficulties arise in the operation of a machine to wire the builder to send a service man immediately, a request that is usually granted free of cost."

In fact, many automobile production engineers give full credit to the machine tool builder for the service rendered in this direction. One engineer stated that the generosity on the part of machine tool builders in regard to free service had really spoiled him. Whenever there was some trouble with a machine that he really could and should fix up himself, it was always a temptation to pick up the telephone and ask for the local service man, who would promptly respond to the call and locate and direct how to overcome the trouble.

The Problems of the Automobile Manufacturer

In selecting equipment for his plant, the automobile manufacturer generally has to consider four main factors: (1) lowest possible investment in equipment; (2) lowest possible labor cost; (3) smallest possible floor space needed; (4) amount of supervision and overhead expense required for different types of equipment. The first two of these factors are usually antagonistic; and so, generally, are the first and third, and the second and fourth. In other words, low investment for equipment generally means higher labor cost and greater floor space. Low labor cost generally means more supervision and greater overhead expense.

The specialization of the workers in the automotive industry has been carried to such a degree that a man rarely has more than one operation to perform. Often several machines and operators work constantly day after day and month after month on the same operation. This presents an opportunity for highly specialized equipment and makes it possible to employ men of limited mechanical skill. As a result, however, the care given to the equipment is not very good and the expense for repairs increases. The lack of mechanical skill on the part of the operators also demands the use of machines that are as simple as possible to operate, and that have no mechanisms that are not essential for the performance of the operation. In fact, mechanisms of this kind constitute a liability instead of an asset, because they require attention and care that they are not likely to receive.

The machine tool builder's problem in connection with the automotive industry is closely connected with the latter's own labor problems. Many machine tool builders believe that the automobile industry as a whole is paying too little attention to the training of mechanics for the future. Very few automobile plants have anything resembling a systematized apprenticeship, and where training shops are to be found, their object is mainly to provide men with sufficient knowledge to become operators rather than all-around mechanics. Too little responsibility for the future supply of skilled mechanics, it is felt, is assumed by what has come to be the greatest mechanical industry in the world, and a large portion of the burden of training mechanics is borne by the machine tool industry, from which are recruited, to a great extent, engineers, shop executives, and skilled mechanics for the automobile plants.

The machine tool builder who is given a chance to replace with modern machines, the old equipment now in use in many automotive plants is enabled to render real service to the automotive industry. Relatively few machines have been bought during the last three years for replacement—nearly all the buying has been to increase manufacturing capacity. Therefore, there are in almost every automobile shop a great many old machines still in use that have earned their purchase price many times over and that are now used at a loss, as compared with the saving in manufacturing costs possible with machines of improved and more advanced design.

Single-purpose vs. Standard Machines

The general tendency in the automobile industry in regard to single-purpose machines, as observed by the machine tool builder, is summed up in the following brief statement quoted from a well-known builder of drilling machines: "I believe that the automobile manufacturer is leaning toward single-function machines rather than single-purpose machines. This appears to be the logical step due to the fact that the automobile is not as yet standardized to such an extent as to warrant the building of wholly single-purpose machines, except in a very few instances."

The ideas of other machine tool builders on the same subject are as follows: "I am convinced that the present tendency is away from the use of purely single-purpose tools. With the possible exception of one or two of the largest automobile manufacturers, it has been demonstrated that excessive writing-off of special machinery has been necessary with the introduction of new car models. The losses due to this have been greater than the savings in production cost while the machines were in use. As standardization continues in the design of automobiles, there will be a broadening field for machines of a semi-single-purpose type, possessing means for producing a given part for several different cars. Such types are already available in certain high-production milling machines for cylinder blocks, high-production boring machines for cylinders, and multiple-spindle drills.

"It has been our experience that the general tendency of the automotive industry is toward the use of standard machines with such special equipment as will provide for the required production at the lowest combined equipment and labor cost. Such equipment has sufficient flexibility so that it can be adapted to new needs when changes in design of the product are made."

The Need for Standard Production Machines

"We feel that the tendency is toward highly specialized, yet standardized production machines, so designed and de-

veloped that the machines are flexible and can readily be rearranged for various classes of similar work. With changing models and the tendency of the automobile business to be consolidated in the hands of a relatively few large manufacturers, it is of considerable advantage to be able to easily change a machine from one job to another, or from one department to another, or even from one factory to another."

"The greatest mechanical problem in the automotive industry is the development, for all operations, of a line of comparatively standard machines adapted to special tooling equipment. The tooling equipment makes the machine special, adapted to the manufacture of one particular part; but by merely changing the tooling, the machine itself is adapted to a reasonably wide range of work. The installation of wholly single-purpose machines is sometimes risky. Some years ago a contract shop purchased a four-way drilling machine, especially made for a differential housing which the shop was making in quantity for an automobile manufacturer. Soon after installing the machine, however, the contract was completed, but was not renewed, and as the shop has never been able to adapt the machine to any other work, it is most likely still standing idle. The writer estimates that the machine probably cost about $8000, and the work could have been done on standard drilling machines, already available in the shop, with an outlay of about $2000 for labor and an expense for jigs of about $1000.

"On the other hand, a standard production machine equipped with special tools may produce as much as a single-purpose machine without the attendant risk of becoming obsolete. Recently, a machine of this type showed the same production as a special single-purpose machine; yet the standard production machine, complete with tools, cost only $4000, while the special single-purpose machine, built to order, cost about $16,000. Further, one man ran two of the standard machines, while the special machine required one attendant all the time."

Machine tools of higher productive capacity than those at present available must include provisions for conserving the physical energy of the operator. When a machine into which the operator places the work and from which he removes it produces at a higher rate than formerly, the operator must also expend more physical effort. He must pick up, clamp, and remove just so many more parts. Thus in solving the production problem, many of the present high-production machines have created an employment problem, and the actual handling ability of the operator often is the limiting factor that determines the production rate.

The same idea is emphasized by a leading milling machine maker, who states that the present tendency is to increase the use of standard machines. "The term 'standard machine' as here employed does not necessarily mean the same kind of machine as it did years ago. In other words, the automotive industry, by its special requirements, has forced machine tool builders to develop a production type machine which is now included in his standard line. These machines, while they are different from the standard machine tools of twenty years ago, can be used on a variety of work, and are not in any sense special machines."

The following statements quoted from builders of a wide range of machine tools also verify the opinions expressed by automobile engineers, as recorded in October MACHINERY, in regard to the use of single-purpose machines and the need for standard production machines.

"The majority of automobile manufacturers," says a lathe builder, "refuse to buy special single-purpose machines, as they have found that when designs change, they cannot use this equipment and, therefore, have some costly experiences in writing off obsolete machines. We have found that the majority of production engineers are getting away from buying the standard type of engine lathes, and while they insist on having multiple speeds and feeds within a reasonable range, they have eliminated a number of attachments, such as screw-cutting mechanisms, compound rests, and other parts, from the standard lathe. In some cases we have been successful in selling the manufacturer whose production is five hundred cars or more per day, special-purpose machines for turning operations. However, as stated above, there is a general tendency among production engineers to avoid buying single-purpose machines."

"A serious defect with the single-purpose machine is that it has no second-hand value when it is no longer needed in the automobile plant; whereas a standard machine always has a second-hand value until it is worn out."

One machine tool builder points out that there never was any pronounced tendency in the automotive industry toward buying entirely single-purpose tools. "The operations in manufacturing all makes of automobiles are so similar that specialized machines have been developed that are applicable in all shops, and the building of single-purpose tools has been unnecessary; only a few really single-purpose tools have been built when no suitable standard tools were available and no machine tool builder could be induced to develop a specialized machine to meet the requirements. Most single-purpose tools owe their existence to the desire of some production man to work out his own pet ideas. There are very few single-purpose tools in use that could not be replaced with equally or more productive standardized tools. The specialized tools are merely machines in which high production has been attained at an expense of range. Instead of being general-purpose machines of wide range, they are applicable to a limited range; but they are not single-purpose machines, and therefore constitute a class of more flexible equipment than single-purpose machines."

Ideal Machine for Quantity Production

"In many automobile plants where machines are seldom changed over from one operation to another, but are kept constantly engaged on the work for which they were purchased, the single-purpose machine is the ideal type, provided frequent changes in automobile design do not make it obsolete," states another machine tool builder. "The ideal single-purpose machine has the fewest possible moving parts, and is designed either for one operation or for a very narrow range of similar operations. Such a machine greatly increases production, lowers the labor cost, and decreases the floor space required for a given number of pieces per day. It also reduces the power consumed and frequently the cost of upkeep. The original investment, however, is higher, because of the special features of the machine. The production required and the likelihood of infrequent changes in the article being manufactured are the factors that determine the savings that may be obtained by the use of such types of machines."

Certain automatic features must necessarily be built into this type of machine. The work of the operator should be confined primarily to loading and unloading and starting and stopping the machine. One operator will be able to run several machines, the number depending upon the nature of the work and the length of the operation. So long as automobile models are changed as frequently as they now are, it is impossible to obtain the highest efficiency in manufacturing. The higher degree of efficiency and lower manufacturing costs obtained by highly specialized machines also necessitate that automobile manufacturers plan future production farther ahead than has generally been done in the past, because the designing and building of special machinery that will properly meet the requirements takes considerable time for studying and experimenting, and requires careful planning ahead.

New Types of Equipment Needed

One machine tool builder suggests that there is urgent need for a high-production method or process for obtaining a highly refined surface in small holes, such as piston-pin holes in pistons and connecting-rods, and shackle-bolt holes in frames. The surface should be similar to a lapped surface and produced by a method faster than internal

grinding, and should be applicable to parts that cannot be broached.

Another machine tool builder sees the greatest field in still further developments of gear producing machinery. In his opinion, "while great progress has been made in the development of machines for cutting gears in quantity, and in gear grinding machines, gear problems are still apparently very prominently before automobile manufacturers. Accurate cutting machines and accurate tools solve only one-half of the problem. The trouble is that the gears have to be hardened, and naturally there is a tendency for them to spring out of shape during this process. While the amount is so slight that in the majority of cases it does not make any difference in the actual working of the gears, the automobile engineer demands such quiet running gears that what may be termed almost perfection is being sought. Machines for the grinding of gears have been developed to overcome this difficulty, but the industry as a whole is not yet satisfied that the final solution of the gear problem has been presented to it."

In the centerless grinder field there will doubtless be still further developments that will prove of great value to the automotive industry. The centerless grinder has brought about a radical change in the grinding practice in many automobile plants.

One of the important problems of the machine tool builder in connection with equipment for automotive plants is to design machines so simple that little or no machine shop experience is required in their operation. They must also be designed so ruggedly that they will stand up under the severe service required of them, and furthermore, the design must permit repairs and replacements to be made quickly without taking the machine out of the production line for any considerable length of time. Simplicity in design, strength, good wearing qualities, and convenience in assembling, are the most important factors.

Improvements in Cutting Tools Needed

Before there can be another great or radical development in machine tool design, aimed at markedly increasing production, there must be a further advance in the quality of cutting tools. Most of the present machine tools are now limited in their productive capacity by the ability of the cutting edge of the tool to stand the service required of it. This is especially true of single-edge tools for lathes and drilling machines and is often also true of milling cutters. Tools having a cutting edge of greater mechanical strength that will withstand greater loads on the tool point and have increased wearing resistance at high cutting speeds would aid considerably in increasing production. It is the need for frequent sharpening of the tools that is one of the most definite limitations to increased production.

The Relation of the Operator to Increased Production

Machine tools of higher productive capacity than those at present available must include provisions for conserving the physical energy of the operator. When a machine into which the operator places the work and from which he removes it, produces at a higher rate than formerly, the operator must also expend more physical effort. He must pick up, clamp, and remove just so many more parts. In solving the production problem, therefore, many of the present high-production machines have created an employment problem. The causes for labor turnover are due to many factors—shop environment, pay, and character of the work. A monotonous job, such as loading and unloading jigs and fixtures, may appeal to some, but it will cause another type of man to quit, especially if, in addition to the monotony, the physical effort that has to be expended is constantly increasing.

Besides the turnover problem, the actual handling ability of the operator often holds back the production rate. Devices for wholly or partly loading machine tools by automatic means are required. Power clamping devices that relieve the operator of the physical labor of pulling up clamps are typical of the needs in this direction. Magnetic and air chucks are applicable to some jobs. The uses of these devices should be extended, and other mechanisms of similar nature developed. Even automatic screw machines may place a burden of physical fatigue upon the operator in case they are of large size and he has to attend several machines, so that a large part of his energy is expended in lifting heavy bar stock into place on the machines.

Departmental as Compared with Progressive System of Manufacture

The old system of departments devoted to special operations, such as a turning department, a milling department, a grinding department, etc., has given way in most automobile plants to the system of "progressive manufacture"; that is, a system under which each unit, like the engine block, the crank case, etc., is wholly completed in one department, passing progressively from machine to machine for the different operations. The object of the change was to make the transportation of parts from department to department unnecessary. One machine tool builder believes that it would have been better to have continued the old system of departmental manufacture and have concentrated on the development of a shop transportation system that would solve the shop traffic problem.

In the progressive manufacturing system, where one unit of the automobile mechanism is manufactured in each department, all the operations being performed progressively as it passes from machine to machine, it is impossible to get the full value out of high-production machinery.

"Today," says this manufacturer, "we have milling machines capable of performing operations at the rate of from 500,000 to 1,000,000 parts a year. We have centerless grinders that are capable of operating on several million parts per year. Shops with a million of each part to make per year are limited, and the parts that run into such numbers are generally only bolts, screws, pins, rollers for roller bearings, and similar parts. There are very few plants that require a million universal joints or a million connecting-rods. Hence, under the progressive manufacturing system high-production machinery would stand idle a good deal of the time, and the lower costs that such machines make possible are not obtained. It is necessary to apply them to more than one part so that the total number of operations they perform will keep them busy the major portion of the time.

"Furthermore, a grinding department, a turning department, and a milling department can be established under the direction of a foreman who is a specialist in his line of work and familiar with high-production machinery of the type used in his department. The main objection to departmental manufacture has been the cost of transporting the parts. We have reached the point where the gains from high-production machinery in charge of a specialist overbalance the transportation costs, and shop traffic systems must be developed that will efficiently meet the situation. This may mean that the tote box, the hand truck, and even the electric truck may have to be supplemented by overhead systems or by transportation subways under single-story buildings. It appears, however, that such a development must be undertaken if the automobile shop is to obtain the highest production possible with modern machine tools.

"The departmental manufacturing system also has some advantages from the employment standpoint. There is somewhat less monotony for the operators who from time to time will work on parts for different units of the mechanism and not on one unit alone. It has been found that labor turnover is often directly related to the monotony of the job, and hence this advantage should not entirely be ignored."

The Weakest Spot in Automobile Manufacturing Practice

To give an idea of the machine tool builder's opinion of the weaknesses in manufacturing practice in automobile

shops, we will quote a number of machine tool builders verbatim. Those particularly interested in this phase of the subject may want to compare these statements with those obtained from production managers and equipment engineers in the automobile plants, as published in November MACHINERY. Each of the paragraphs below contains a quotation from a different machine tool builder.

"The weakest spot in the manufacturing practice of the automotive industry would seem to be the very large number of obsolete machines still in use even in the largest and best equipped plants. It may be thought that a machine tool builder's opinion on this point might be biased, but I believe the statement made to be in accordance with the facts."

"We consider that the weakest spot in the manufacturing practice of the automotive industry is that a number of automobile builders do not take full advantage of what the machine tool manufacturer has developed for this industry. Some automobile manufacturers refuse to purchase improved machine tools unless the cost of the equipment can be saved in one or two years. This, in our opinion, is too brief a period; it should be an economic advantage to purchase new improved equipment whenever the savings due to the new equipment will pay for the machines in four or five years."

Changes in Personnel Hamper Plant Efficiency

"I think the weakest spot in the automobile manufacturing practice is the constant changes in many of the organizations. Many of the leading men in these organizations frequently change from one automobile plant to another because their services are valued on account of their known ability. This may be of advantage to the individual, but the industry as a whole suffers, and the organizations that do not make an attempt to retain their capable men suffer most. On account of these frequent changes, there are some automobile plants where there are no fixed policies and where a continuous equipment program is not carried out. When a new man takes charge, it is evident that he prefers certain machines, methods, and systems that he has become acquainted with in a former plant, and he is liable to base his conclusions on past experience rather than to investigate closely the conditions as he finds them. This choosing of machines with which the man responsible has past experience rather than newer machines that may be more effective has led to the installation of equipment, in some instances, that does not give the maximum output that could be obtained had the plant gradually and consistently followed a fixed policy of investigating and choosing the best."

Need of Cooperation between Different Plants of Same Company

"Frequently when several plants are operated by the same company there appears to be a lack of cooperation between the various plant organizations. There is no agreement, for example, as to the kind of equipment that ought to be installed for similar purposes. There are several large automobile companies operating more than one plant, and it is not unusual to find one type of machine in one plant and an entirely different type in another plant, producing the same part or product, but at an entirely different rate of speed and hence, at a different cost. To an outsider it would appear that it should be possible to determine upon which method is the best to follow, and then to equip the various plants in accordance with the conclusions arrived at. Closer cooperation between different plants, or a general investigation organization which would determine upon the equipment to be used in the several plants, would probably lead to decided economies."

Importance of Attention to Details

"Based on a rather large experience in supplying special equipment to automobile companies, it seems to us that the average automobile producing organization is not accurate enough in its attention to details, with the result that there is considerable waste of time, money, and effort. The industry has conceived of many new basic ideas for methods and devices, but rarely are these ideas analyzed in sufficient detail and the requirements investigated with a sufficient thoroughness so that the machine tool builder can obtain all the detailed information that he needs for meeting the requirements.

"Furthermore, we have found that such details as proper cutter equipment, proper wheel equipment, proper grinding of cutters and drills and cutting tools in general, which in themselves have a very large bearing on the production capacity of expensive machine equipment, and hence on costs, are often left entirely to the foreman of a department, who may neither have had the experience nor the opportunity to make careful investigations, and therefore is unable to properly select the auxiliary equipment and the methods of caring for it."

Many machine tool builders believe that the automobile industry as a whole is paying too little attention to the training of mechanics for the future. Very few automobile plants have a systematized apprenticeship, and where training shops are to be found, their main object is to provide men with sufficient knowledge to become machine operators rather than all-around mechanics. A large portion of the burden of providing a future generation of mechanics is now borne by the machine tool industry from which have been largely recruited engineers, shop executives, and skilled mechanics in the automobile plants.

Lack of Balance in Production Schedule

"There is a pronounced lack of balance in automobile production at the present time. There certainly must be some means of avoiding the severe ups and downs in the automotive production curves. When the industry has found its proper balance, it doubtless must be possible to maintain a more even production throughout the year, because on the whole the demand for the automobile builder's product is a steadier demand and the fluctuations in annual sales are less than those with which practically every other builder of machinery has to contend.

"The method ordinarily employed in making improvements in manufacturing methods, also appears wasteful to us. The average automobile builder usually waits until a new model is brought out to put into effect new methods and improved machinery. The result is that at this time there is such a rush to 'get into production' that there is not sufficient time to devote to proper investigations that should precede the investment of money in new facilities. Some well-known builders have departments devoted to giving sustained effort to improve efficiency and lower costs, and it would seem that this method ought to be followed in all plants. Such a plan would bring greater results for the expense involved and would also tend to eliminate wasteful peaks of abnormal activity."

The Difficult Problems of the Automobile Industry must be Recognized

A somewhat less critical view is taken by some machine tool builders who are making allowances for the great stress placed upon an industry that has developed at such rapid strides as the automobile industry. One of these makes the following statement:

"Manufacturing practice in the automotive industry is highly specialized, and in most of the plants with which we are familiar it follows carefully laid out programs resulting from intensive thought and careful deliberation. We believe that the suggestions for improvements, for eliminating any weak spots within these organizations, must come from within the organizations rather than from outside sources. Methods that look erroneous to the outsider may often be the best ones that can be adopted under the prevailing conditions, due to factors that may not be subject to change and that may be the controlling items in the whole structure."

PEAT

Peat consists of decayed vegetable matter and earth, and is found in bogs and swamps. It is cut out and dried, and sometimes pulverized and compressed into blocks before burning. It gives an intense heat, burning with a short blue flame which changes to yellow when the grate spaces become filled with embers. One pound of air-dried peat contains about 7700 B.T.U.

TURBO-COMPRESSORS

A turbo-compressor is a multi-stage centrifugal compressor, which is built for delivering air from pressures of 5 or 6 pounds up to 120 pounds or more per square inch. In principle, it is like the high-lift turbine pump; the air, upon entering the impeller near the center, is thrown outward by the blades, and its kinetic energy, due to the high velocity, is changed into pressure in fixed diffuser channels, and led back toward the center to the inlet of a second impeller, and so on, the pressure increasing with each stage. An important matter in connection with air compression is that of cooling. For the low pressures of the single-stage compressor, this is not necessary, but for higher pressures, jacket cooling is provided. The turbo-compressor type of machine is particularly well adapted to the removal of heat from the air, because the distance traveled through is much greater than in the cylinder compressor, and the cooling is made continuous by circulating the water through passages between the diffusing chambers of each stage. The advantages of a turbo-blower over other types of blowing engines are the steady flow of air, ease of governing, simplicity of construction, lower first cost, and small space required. On the other hand, gas-engine driven compressors of the piston type are operated with a by-product which may be had practically free of cost. The turbo-blower, when driven by a direct-connected steam turbine, makes a very compact and efficient unit. When exhaust steam is available from high-pressure engines or turbines, it may be utilized in a low-pressure turbine for driving the compressors.

RIVETING BY ELECTRICAL METHOD

The "electric riveting" process consists in first heating the rivet by electrical means and then subjecting it to sufficient pressure to form the head. The machine used resembles the well-known spot-welder, and in its simplest form is provided with two opposing copper electrodes, the upper of which is movable vertically. After the rivet is in position, the upper electrode is brought down into contact with it. The current induced in the secondary winding of a transformer then flows through the rivet, quickly heating it to the required temperature; then the current is cut off and a greatly increased pressure applied, thus upsetting the rivet and forming the head. The heating of the rivet occurs so rapidly that there is little loss by radiation or conduction.

LOAD FACTOR

The load factor of a machine, plant, or system is the ratio of the average power to the maximum power during a certain period of time. The average power is taken over a certain period of time, such as a day, a month, or a year, and the maximum is taken as the average over a short interval of maximum load within that period. In each case, the interval of maximum load and the period over which the average is taken should be definitely specified, such as a "half-hour monthly" load factor. The proper interval and period are usually dependent upon local conditions and upon the purpose for which the load factor is to be used.

PIPE THREADS WITHOUT TAPER

The following information conforms to the American Standard pipe threads and to the standard approved by the National Screw Thread Commission: The straight pipe thread has the American or Briggs tapered pipe thread in regard to pitch and depth of thread. The basic pitch diameter for straight pipe threads equals the pitch diameter at the gaging notch of the tapered plug gage. Occasionally it is advisable to use a straight pipe thread of the largest diameter it is possible to cut on a pipe. This thread has also been standardized and is designated as the "maximum external and minimum internal lock-nut threads." The pitch of this lock-nut thread is the same as the pitch of a standard taper thread of corresponding size. To illustrate the difference between a straight lock-nut thread and the straight pipe thread first referred to, consider the difference between the diameters of the 1-inch normal size. In the case of the straight pipe thread the basic pitch diameter is 1.2386 inches, whereas, in the case of a lock-nut thread, the maximum pitch diameter for an external thread is 1.2603 inches. The straight external pipe threads are recommended only for special applications, such as long screws and tank nipples. In gaging, the tapered working plug gage for the American or National standard is used, allowing the same tolerance for the notch as for a taper thread.

VANDYKE PRINTS

Vandyke negatives have white lines on a brown background. If positive prints are desired or those having either blue or brown lines on a white background, they may be obtained in the following manner: The original tracing is first used to make a negative copy on thin vandyke paper. This copy will have white transparent lines on an opaque dark brown background. Another print is then made by using this vandyke negative in place of the original tracing, and the result is a positive print which will have dark lines on a white background if vandyke paper is used, or blue lines on a white background if regular blueprint paper is used. Similar results may also be obtained on cloth by using either prepared blueprint cloth or vandyke cloth, depending upon whether a blue-line or a brown-line print is desired.

SYNCHROSCOPE

A synchroscope, or synchronism indicator, is a device which, besides showing when two alternating-current systems are in synchronism, also indicates which system has the higher frequency, the difference in frequencies, and the phase relation when the frequencies are equal. They are commonly of the dynamometer or the moving-iron types, being similar in their operation to power-factor meters in that their indications are dependent upon the phase difference between two currents.

GAS ABSORPTION BY WATER

Water will absorb 1/20 of its volume of oxygen, about its own volume of carbonic acid gas, and 430 times its volume of ammonia. The weight of gas that will be absorbed by a given volume of water is proportional to the pressure. The volume of a mass of gas, however, decreases as the pressure increases, so that the volume which a given amount of water will absorb at a certain temperature remains constant whatever the pressure. Water will absorb its own volume of carbonic acid gas at atmospheric pressure. If the pressure is doubled, the gas will have twice the density, and twice the weight of gas will be dissolved, but the volume dissolved will be the same.

LANTERN PINIONS

Lantern pinions are formed of two disks between which are "rounds" of steel wire or rod to serve as teeth or "leaves." This type of pinion has been used extensively in clock mechanisms, and formerly was employed in connection with primitive millwright work. Lantern pinions are not adapted to driving, and in clock mechanisms they are the driven members. An accumulation of dirt that would stop the action of an ordinary cut pinion is simply pushed through between the rounds of a lantern pinion, which, therefore, continues to function. This is an important advantage of this type of pinion as applied particularly to low-priced clocks which frequently operate under unfavorable conditions.

BAILY'S METAL

Baily's metal is an alloy composed of 82 per cent of copper, 13 per cent of tin, and 5 per cent of zinc, which was used for making the standard imperial yard of Great Britain and the standard yard of the United States in the Bureau of Weights and Measures. It has also been used for making nearly fifty copies of the standard yard supplied by the British government to foreign governments and public institutions.

MECHANICAL STOKERS

A material saving in labor can usually be effected by the installation of mechanical stokers in large and medium-sized power plants, as compared with hand firing. The cost of maintenance and initial cost of grates for hand firing is less than for mechanical stokers, but the coal is fed uniformly by mechanical stokers, which insures constant temperature and steaming. With hand-fired boilers, the furnace doors are opened frequently, which tends to chill both the fire and the furnace setting and is conducive to the production of smoke. Unless skilled firemen are employed, the efficiency of the hand-fired boiler will be lower, because of the greater heat content in the ash, holes in the fire bed, etc. Skilled firemen are also essential for mechanical stokers; but there are not so many required, and the men have more time to use efficient firing methods. Mechanical stokers may be divided into three general classes: The *chain-grate* stoker, which carries the green coal in the combustion chamber on a horizontal surface and depends upon the reflected heat from the brick arch above it to ignite it; the *inclined-grate* or *over-feed* stoker, which depends on the green coal feeding down over the fire bed, and the *under-feed* stoker, which forces the green coal in under the fire bed and utilizes forced draft. There are numerous designs of each of these classes.

CAPILLARY ACTION

When a tube of glass, the bore of which is very small in diameter and which is open at both ends, is placed vertically with its lower end immersed in water, the water will rise in the tube and will reach a higher level on the inside of the tube than the level of the water outside. The force or action which makes the water rise higher inside of the small-diameter tube is known as "capillary action." The same name is used for many other phenomena observed in the properties of liquids when spread over surfaces. Capillary actions are explained by reference to surface tension, cohesion, and adhesion between the molecules, etc. Capillary action is of importance in many devices used for lubrication, the oil rising against gravity along a wick and thereby reaching the surface to be lubricated.

VENTURI METER

The Venturi meter is an instrument for accurately measuring the discharge of fluid or gas through a pipe. The meter consists essentially of an hour-glass-shaped section of pipe, with smoothly rounded internal walls into which two gages are fitted, one at a point where the pipe is of full diameter, and one at the smallest section or opening in the pipe. By means of the pressure recorded by the two gages and the use of certain constants that have been calculated for various diameters of pipe, the discharge through the pipe may be determined.

FLEXIBLE COUPLINGS

Flexible couplings are the most common mechanical means of compensating for unavoidable errors in alignment of shafts and shafting. When correctly applied, they are highly efficient. For joining lengths of shafting without causing loss of power from bearing friction due to misalignment, and for use in direct motor drives for all kinds of machinery, the value of the flexible coupling is now generally recognized. The fact that lineshafting will sag if of considerable length, makes the use of a flexible connection essential. Flexible couplings are not intended to be used for connecting a driven shaft and a driving shaft that are purposely placed in different planes or at an angle, but simply to overcome slight unavoidable errors in alignment that develop in service. There is a wide variety of flexible coupling designs; most of them consist essentially of two flanged members or hubs, fastened to the shafts and connected by some yielding arrangement. The question of balance is an important matter in coupling selection or design, as an increasing number of couplings are used in connection with steam turbines, high-speed motors, and many other classes of machinery. It is not sufficient that the coupling be perfectly balanced when installed, but it must remain in balance after wear has taken place.

MALLEABLE IRON BRITTLENESS

Numerous tests on samples of commercial malleable iron, mostly impact tests on specimens heat-treated at relatively low temperatures, show that the embrittlement of malleable iron sometimes noted in hot-dip galvanizing is due chiefly to the incidental heat-treatment. Quenching malleable iron from temperatures between 400 and 500 degrees C. (750 and 930 degrees F.) makes it brittle to a greater or lesser degree, depending on the iron. The rate of heating and the time the metal is held at this temperature exert but little influence. Ageing after treatment has no apparent effect. On the other hand, substituting slower rates of cooling for the quenching treatment produces a metal of higher impact resistance. Heating to 650 degrees C. (1200 F.) for a few minutes, followed by quenching (in water at room temperature), eliminates the embrittlement, even if the metal is subsequently galvanized.

HOT-WELL

"Hot-well" is the name given the reservoir that receives the cooling water and the condensed steam from a jet type of condenser, or the condensed steam from a surface condenser. The hot-well need not be closed tight, as there is no pressure in it, and it simply serves as a cistern for holding the warm water discharged from the condenser. The feed pump for the boiler of a condensing engine draws water from the hot-well. In land practice, the hot-well is usually arranged with an overflow so that the excess of water not needed by the boiler may escape.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

MACHINE TOOLS IN AUTOMOTIVE SHOPS

It was with a great deal of interest that I read the article "The Automotive Industry and the Machine Tool Builder," in October and November MACHINERY. You have certainly described the conditions accurately as they exist at the present time, not only in the automotive industry but in other lines as well. The machine tool builders' view will be looked forward to with much interest. This series of articles may be the means of bringing the machine tool builder and the user closer together, with the result that there will be better machine tools and more replacement of old equipment much sooner than would otherwise have been the case. Articles of this nature are of great interest to readers of MACHINERY in all plants using machine tools. MACHINERY is to be congratulated on such a type of article for the reason that both machine tool builders and users will obtain real benefit from reading it. E. B.

Commenting on the subject of single-purpose versus standard machine tools for the automotive industry, referred to in the leading article in October MACHINERY, I have found it very difficult to determine at times whether a special machine may be justified instead of a standard machine with a special fixture equipment. The automobile manufacturer, when he is not able to obtain a machine tool that seems to meet in all particulars his own ideas unless he has the machine built to order, often resorts to the making of special jigs and fixtures embodying the idea of a special machine and applies these jigs and fixtures to standard machines. When the jigs and fixtures have been built, it is often found that their cost in conjunction with the cost of the standard machine is higher than would have been the cost of a special machine requiring no special tooling equipment and that might have been more efficient for the purpose. On the other hand, in this connection it must also be remembered that the standard machine can be applied to other work later on, whereas the special machine, although its first cost may have been no higher than the standard equipment with special fixtures, can be used only for the work in hand.

The writer has found this problem one of the most difficult to deal with and only by most careful analysis in each special case will it be possible to determine when and when not a standard machine with special fixtures and tooling equipment will prove more economical than a special machine. The automotive equipment engineer must not jump at conclusions. If he wants to obtain the greatest possible manufacturing economy, he must learn to analyze every detail of the problem, put it down in figures, and determine from the figures upon the best procedure.

EQUIPMENT ENGINEER

I read with interest the article in October and November MACHINERY on machine tool equipment for automobile shops. It seems to me that the machine tool builder's greatest problem at present in the automotive industry is to so design and construct his equipment that wear will be reduced as much as possible and the cost of replacements and adjustments cut down. I have in mind especially spindles, bearings, gears, and other driving mechanism. Special heat-treatments and the use of alloy steels, as well as the more generous proportioning of ways, sliding surfaces, and other moving parts where the stresses are severe, will doubtless aid in accomplishing this.

Among equipment that is needed for automotive plants may be mentioned more highly developed heat-treating equipment, built especially for the production needs of plants of this kind. The ordinary furnace or oven, or even the continuous furnace for all-around work, bears the same relation to automotive production as does the tool-room milling machine when used for production work. The Ford Motor Co., Dodge Bros., and a few of the other large automobile concerns, are now installing machinery that may be called single-purpose production heat-treating equipment. Generally speaking, I believe the weakest spots in the manufacturing practice of the automobile industry are the heat-treating department, the forge shop, and the foundry. Forging practice, particularly, appears to me to be behind the times.

In the plants where very large output of the same type of car is the rule, the present tendency is certainly toward the increasing use of highly specialized single-purpose equipment. General utility machines or equipment for flexible application are not effective. Just as all modern manufacturing plants are adopting a progressive production method, so the individual machine performing the operations in the steps of the progressive production must become more highly specialized. The day of separate milling machine departments, drill press departments, and lathe departments is past; today each department is laid out for performing all the progressive operations on single units of mechanism.

L. A. D.

ASSEMBLY DRAWINGS VERSUS DETAILS

Referring to the article "Assembly Drawings versus Details" in October MACHINERY, page 111, it is the writer's opinion that it is more practical and economical to use detail drawings in the shop than it is to employ only assembly drawings. In the first place, it is impossible in many cases to use the "assembly" system for small complicated parts, because so many dimensions and dimension lines are required that the drawing becomes confusing, even when made to a very large scale. This is also true in the case of assembly drawings of many large machines.

With the assembly system, practically every man in the shop requires an assembly blueprint. When a part is changed, these assembly prints must be recalled and an entirely new set issued. There is always the possibility of one or two of these prints being overlooked and, of course, parts made according to the old prints will not fit those made from the new ones. In the detail system, where only one print, or possibly two prints, of each detail are issued, the cost of changing a part, so far as the prints are concerned, is greatly reduced, because fewer prints must be replaced. Then, too, the detail prints are usually much smaller than assembly prints, which means a considerable saving in blueprint paper.

The assembly system is also a disadvantage as far as the apprentice is concerned, because he must learn to read blueprints the same as he must learn to operate a machine, and it is obvious that a detail drawing can be read much more easily than an assembly drawing, and that if the apprentice has a detail drawing to work from, he will get a better idea of the piece he is to make. When the apprentice clearly understands the detail drawing, he can refer to the assembly blueprint (one assembly print is usually sufficient for each shop) and see just how the part that is shown on the detail drawing is used in the machine.

JAMES T. KILPATRICK

The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, November 15

THE sudden political change that has taken place in England has engendered a rapid spread of that feeling of security that is impossible without stable government. The prospect of five years without a political upheaval is bound to react favorably on trade and industry generally. An index of the change of outlook can be gathered from the remarkable increase of activity in the purchase of industrial shares, while the value of the British pound has advanced in practically every country.

The machine tool industry has probably suffered more than any other from the general hesitancy in development, and under such circumstances the amount of business that has actually been effected gives promise of a considerable expansion with the growing improvement in industry in general. The Midland area was the first to revive, and machine tool makers in that locality still hold a substantial lead over other areas. The flow of business is still inclined to be erratic, but new machine tools are being ordered with more freedom, and inquiries are now more general.

Machine tools for railway shops are relatively strong, and turret lathe and screw machine makers are so busy that they find it impossible to accumulate stock. A feature of a majority of orders received at the present time is the stipulation of prompt delivery. In some machine tool shops that have ample facilities to cope with the increased business, there is a serious shortage of the special class of skilled labor required, and it is feared that recent slack times have resulted in this valuable class of employe drifting into other industries. Apprentices also are not numerous, despite the sympathetic attitude of many firms toward apprentices and the establishment of schemes to further their technical education. A substantial proportion of the machine tool output of this area is destined for overseas markets; one maker states that no less than 90 per cent of his present orders are for shipment.

In the Yorkshire area, several machine tool manufacturers report a distinct improvement, and several orders can be traced to the recent machine tool exhibition at Olympia. Some shops in Halifax that include some of the lighter classes of machine tools among their products are working over-time. Radial drilling machines in this locality are finding a steady demand, and center lathe builders show more activity than for a long time past. The new Berry presses that accomplish very deep drawing operations with only one stroke of the press are bringing a good deal of work to the makers of these presses.

Overseas Trade in Machine Tools

During September the exports of machine tools showed an increase in value of nearly £20,000 over those for August, the figures being, respectively, £120,247 for 1048 tons, and £106,264 for 880 tons. The value per ton fell in September to £114, as compared with £121 for August. Imports showed a decided drop in September in both value and tonnage, only 187 tons with a value of £32,765 coming into the country; in August the corresponding figures were 440 tons with a value of £72,823. The value per ton of September imports was £175, as compared with £166 for August. The exports of machine tools for the first nine months of this year are 24 per cent below the average tonnage of a corresponding period before the war, 3 per cent below the first nine months of 1922, and 16 per cent below that period in 1923.

During this year fairly heavy consignments of lathes, presses, drilling and milling machines have been received from Germany and America; grinding machines also form a fair proportion of America's exports to this country. The maintenance of a very high average ton value is a striking feature of imported machines.

Before leaving the question of machine tools it may be of interest to note that Parliament now includes H. G. Williams, the secretary of the Machine Tool Trades Association, who is fully competent to watch the interests of the machine tool industry.

General Engineering Field

Apart from large contracts in connection with municipal and public service undertakings, the bulk of orders being placed in the engineering industries is not heavy. Some of the large electrical concerns are busy, but others report a scarcity of orders. It is thought that the expectations held out as regards the amount of engineering business that could be obtained in Russia if trading conditions were simplified, have been somewhat exaggerated. Russia never was a heavy purchaser, as compared with some other countries, and the prospects held out by Colonial development, in any case, are of considerably greater magnitude.

Boilermakers and power house plant builders show signs of recovery, and inquiries are increasing. Constructional engineers are quiet, but rolling stock builders continue to be fairly busy. Manufacturers of food supply equipment, such as sugar machinery, confectionery machinery, mechanical packers, and handling equipment are well supplied with orders. Other branches of the engineering industry that show improvement are those making shoe machinery, hosiery machinery, conveyors, and laundry machinery.

The Automobile Industry

An examination of the latest productions of British automobile makers, which were to be seen at Olympia last month, proves conclusively that they are quite holding their own in respect to design, accuracy of manufacture, quality of material, and price. Still more important is the evidence that the practice of systematic manufacture, with its resultant low selling price, is gradually spreading through the industry. For £150 ($690, present exchange), it is now possible to obtain a fully equipped car. Three years ago such a sum would barely purchase a side-car combination. Altogether, the exhibition offers a remarkable evidence of the vitality and resource of the British automobile industry. This industry, which is the third largest of the engineering trades, employs 200,000 workers, who receive £350,000,000 (about $1,380,000,000) a year in wages.

There is a further increased activity in the works devoted to automobile production, and in the case of some popular models, production plans are being made on a much larger scale than last year, and extra equipment is being installed. The bicycle and motorcycle trades are also booming, and in each case have nearly the whole of the home trade, and are extending rapidly in overseas markets.

Shipbuilding

The latest returns show that 1,468,000 tons of shipbuilding were under construction on September 30 in British yards. This represents an increase of 197,000 tons over a year ago. About 25 per cent of the tonnage now building is to be motor-driven. At the present time 35 vessels of between 10,000 and 20,000 tons are being built in the world's shipyards; of this number Great Britain claims 20. Of vessels over 20,000 tons, eight are under construction, all in British yards. Work on the development of large Diesel engines for fast passenger ships is being actively carried on.

Current Editorial Comment

in the Machine-building and Kindred Industries

SAVING MONEY ON MAINTENANCE

The old saying, "An ounce of prevention is worth a pound of cure," applies particularly to the maintenance of machine shop equipment. Too many shops permit machines and tools to run down until a breakage requires extensive repairs and causes a costly interruption in the production.

At the Production Meeting of the Society of Automotive Engineers recently held in Detroit, it was pointed out by Mr. Blackburn, plant engineer of the Olds Motor Works, that by competent supervision, breakdowns and the accompanying costly production delays can be almost entirely avoided. In a small shop, one man can be detailed to take care of repairs and maintenance, and in a larger shop a separate department can be organized, the duties of both being not only to make repairs, but to avoid them. Motors are inspected at regular intervals and needed adjustments made. Such machine parts as usually require replacement from time to time are frequently inspected, so that replacements may be made before there is a complete breakdown of the machine, sometimes accompanied by serious damage. Needed repair parts are kept on hand and there is no delay when necessary replacements must be made—this perhaps is one of the most important items to be considered in this connection.

To render this inspection and maintenance work effective, a simple system is required: The work of the machine repair department begins with the arrival of a new machine in the plant. Every machine is numbered and a card record is made of it. This record contains all the data necessary for completely identifying the machine in case repair parts must be obtained. On the back of the card appear the names and identifying numbers of parts that are usually subject to breakage or wear. Such parts are immediately ordered, so that one set of repair parts is always on hand. Upon their arrival, the parts are plainly marked with the machine number and kept in a special store-room containing machine repair parts only, so that there is no question as to where the parts are when needed.

Good judgment is always necessary in order to prevent waste. It would be wasteful to carry all breakable parts in duplicate; but often it has proved more economical to have a few parts on hand that never may be required than to lack parts when repairs are urgently needed. The cost of having an important machine stand idle for a few days while a telegraphic order for repair parts is being filled, would pay for many unused parts kept on hand to meet an emergency.

* * *

CHANGES IN STANDARDS

Whenever a machine element or a product is adapted to general use by manufacturers, standardization covering a range of sizes and important dimensions has obvious advantages. It is unfortunate, however, that standards are subject to so many changes which could be avoided by more thorough preliminary investigations. We realize that changes are sometimes necessary owing to developments, but too frequently they are the result of approving a standard which was issued without thorough research to determine all essential factors. Some standards, in fact, are considered by their sponsors as more or less tentative, the idea being to change them whenever a more thorough investigation indicates that alterations are desirable—an investigation that ought to have been made complete in the first place.

Since standardization is intended to give manufacturers the benefit of uniformity and approved data, thus avoiding costly and unnecessary variety, it follows that the *manufacturer's* interests should be paramount in all standardization work. The industries need standards which are change-proof, except as they might be affected by subsequent conditions which could not be foreseen when the standard was established. Delay in issuing a standard surely is much better than hasty action which must soon be followed by corrective changes.

The engineering handbook is the most effective means of distributing standardization data, and users of such books naturally consider, as reasonably permanent, standards approved by engineering societies. Therefore, when changes are made, the original data continues to be used by many who know nothing about the changes, which leads to confusion and errors. It may be a relatively simple matter to alter an established standard, but after it has been circulated throughout an entire industry, and perhaps internationally, the universal replacement of the original data is practically impossible within a reasonable time. It is evident then that unnecessary changes tend to thwart the primary purpose of standardization.

* * *

SAFEGUARD THE EYES

More and more industrial concerns are realizing the need for general and systematic efforts to safeguard the life, health, and sight of workers. Health departments have been organized in many of the larger plants with a doctor and nurse in attendance, and safety devices are being provided so that the operator may not be exposed to danger.

Among the most serious and unfortunately the most common accidents, are those affecting the eye. It is stated in a report recently issued by the National Committee for the Prevention of Blindness that of the 100,000 blind people in the United States, 15,000 have been blinded through industrial accidents.

There are three general classes of industrial eye casualties which must be guarded against: (1) Accidents due to flying chips of metal or other materials; to the splashing of liquids, such as molten metal, acids, or other dangerous chemicals; and to explosions. (2) Infection and eye diseases due to neglect of slight eye injuries, incompetent aid in removing particles from the eye, or exposure to excessive heat. (3) Eye strain resulting from inadequate lighting, and ignorance or disregard of the presence of defective vision.

These different causes and the means that may be adopted to guard against serious results from them are well covered in the report mentioned, which may be obtained from the National Committee for the Prevention of Blindness, 130 E. 22nd St., New York City.

Health departments to look after the physical condition of the worker are not merely philanthropic institutions in industrial plants. Frequently they pay real dividends in dollars and cents by reducing the time lost through accidents and sickness, and by preventing serious interference with production. Smaller plants cannot afford, nor do they need, a shop hospital; but every plant can take simple precautions to prevent accidents and to provide safe working conditions, including adequate light to prevent undue eye strain, guards to prevent the flying of chips, and goggles for those workers whose eyes especially need careful protection, such as those engaged in grinding work, chipping, and similar occupations.

Standardization and the Executive

By GEORGE M. MEYNCKE, Sales Manager, Oesterlein Machine Co., Cincinnati, Ohio

THE subject of standardization has been under discussion for many years, and after much appointing of committees and reporting of progress, some good work has been accomplished. Standardization in the machine industries began with small machine units in general use, such as screws, bolts, and keys. Up to the present time it has not gone much beyond that point, and it is not likely to progress fast enough to bring any really practical results unless the value of standardization is appreciated by the executives of manufacturing concerns; because it is the executive who must provide the impetus for further work along this line.

In the past, standardization has been regarded as something for engineers to handle, and as long as the engineer was content with standardizing screws, bolts, and keys, the executives in the industries encouraged standardization work and made it possible for the engineer to attend standardization meetings. But the greatest value of standardization is in a field over which the engineer does not have complete control, and in this field there will be no progress until the executive heads of our industries take an active interest and themselves do constructive work toward the application of standardization.

George M. Meyncke

Obstacles in the Way of Standardization

The great obstacle to effective standardization is the fact that competitive conditions make it appear as if lack of standardization might prove of benefit to individual concerns. Thus, for example, when the engineer proceeds beyond screws, bolts, and keys and begins to talk about, let us say, T-slots, tapers, and spindle noses, he enters upon a field where commercial rather than engineering considerations must be the guiding influences, and hence the executive head of the business rather than the engineer must study the problem and decide upon what can and should be done.

The great difficulties to be overcome must not be minimized. When the engineer points out the inconvenience of the absence of standard T-slots or spindle noses, the sales manager points out the actual or probable objection of a good customer who has installed a number of machines built according to present specifications. The sales manager, seeing the immediate prospect for repeat orders, would rather fall in with the customer's views than to jeopardize the immediate sales chances by trying to convert him to the ultimate advantages of new standards.

The sales department fears, for example, that if all T-slots or spindle noses were alike, competitors would have a better chance of breaking into the field that this particular selling organization has staked out as its own. The sales viewpoint is likely to have more weight with a chief executive than the engineering considerations of the manufacturing department, and efforts toward standardization beyond certain elementary details, therefore, do not receive very much encouragement.

Keen Competition Does Not Aid Standardization

Frequently the sales department encourages departures from designs or dimensions that have become semi-standardized through years of common practice, even though they may not have been officially accepted by any society or association. As an example, the writer wishes to mention one case with which he is particularly familiar—that of milling machine spindle noses. At one time there was a tendency toward standardizing milling machine spindle noses, but because face mills are difficult to remove from single-threaded spindle noses, someone proposed the idea of radically changing the spindle nose. It is doubtful, however, if this change was not made rather because the sales department wanted to create a new selling point than because the engineer found it necessary to remedy the face-mill trouble in this manner.

After the first spindle nose of this type had been designed, it became necessary for other milling machine manufacturers to design the spindle noses on their machines so that they, too, would have a satisfactory selling argument. Between the sales department and the engineer who is fond of creating designs with more features than any other engineer has been able to think of, a situation in regard to milling machine spindle noses has been created that is much further removed from a possible standard than it was fifteen years ago, and it has made the adoption of an entirely new standard spindle nose more difficult and more expensive for both the manufacturer and the user of milling machines. It has forced some milling machine builders to make adapters, and to make their own face mills to fit their machines, and the sales advantages gained in the first place have probably been lost by the necessity of introducing these auxiliary lines of manufacture which seldom have given profit, but more often loss.

The direct interchangeability of the chuck between the main spindle and the dividing head spindle has been made impossible. It has created a much larger number of different designs for the small tool maker and the chuck maker to keep in stock or to be prepared to furnish, and it certainly has made face mills and mounted chucks more expensive. It has further retarded the development and use of tools and attachments that apply to spindle noses, and may in this way have hindered the expansion of the field of milling machine application, especially as far as the standard line of milling machines is concerned. The case of milling machine noses has merely been used as an example of the influence of competition and sales effort upon engineering features and standardization.

Does Standardization Retard Sales?

There seems to be an opinion, which is very strong with sales managers and is often also shared by the chief executive, that standardization of really important construction details would adversely influence sales, because it prevents individuality in the manufacturer's product. This opinion, the writer believes, is due to the fact that the scope or the application of the term "standardization" is not so well understood outside of engineering circles as it should be.

The object of standardization is to save expense by eliminating odd sizes, useless sizes, and "artificial" sizes. The bigger the units, the greater the saving due to such elimina-

tion. The introduction of a machine that differs only a few inches in capacity from another line of machines, for competitive reasons, would be of advantage only if the competitor could be prevented from introducing a similar machine; but inasmuch as any efforts of this kind will always be followed by similar efforts on the part of competitors, the result is simply that two or more manufacturers find themselves forced to build a number of sizes not actually required by the trade and from which nobody has gained any advantage. Soon all the manufacturers in a given line are spending more money on building what might be termed "artificial" sizes of machines. If it is possible to save by standardizing screws, bolts, and keys, it is possible to save still more by standardizing on a comparatively few actually needed types and sizes of machines.

During the world war, one milling machine manufacturer suggested that every manufacturer standardize on one size of machine—that is, one shop would build only No. 1 machines, another No. 2, and so on. This was the most sweeping standardization proposition that had ever been suggested in the industry, and if it had been possible to work out a plan whereby it could have been accomplished, there would have been greater output, less confusion, more profit, and less inventory, to the benefit of all concerned, including the buyer and user of machine tools.

Do not believe that this difficulty in the way of standardization is met with in machine tools alone. It is met with in practically all industries. It will be recalled that during the war period there was a limitation in passenger car models put out by automobile builders, but this effort toward standardization, with its attendant production advantages, did not last long. One automobile builder who had seven body styles in 1919 now has a line of twenty-three different models!

Business Depressions are Antagonistic to Standardization

When there is a depression in business, there is always a temptation to branch out into more numerous types and sizes than when business is good. A sales manager may report that he thinks he could sell machines like those of a competitor if he only had them to sell. When business is brisk, the chief executive will say that "this type of machine is out of our line"; but during a business depression he is tempted to say "we may as well make whatever our customers want." When he yields to this temptation, he soon finds that he has spent money and split up orders to the point where neither he nor his competitor gets any return on their investment, and nothing constructive has been accomplished either for the benefit of his own business or for the industry as a whole.

In conclusion, the writer wants to sound an optimistic note. He believes that there is at present a greater appreciation of the need for real standardization on the part of the executives in all our industries than there ever has been before. They understand that there are sound economic reasons for standardization. They realize that the greatest gain from standardization is the elimination of unnecessary sizes, odd capacities, and radical departures in design that affect the dimensions of other tools and accessories made by other concerns. When the chief executives in our industries begin to think standardization and investigate its value as applied not only to minor details in the shop but also to the product as a whole, we will have real progress along this line, and it will prove of benefit alike to machine builders and machine users.

* * *

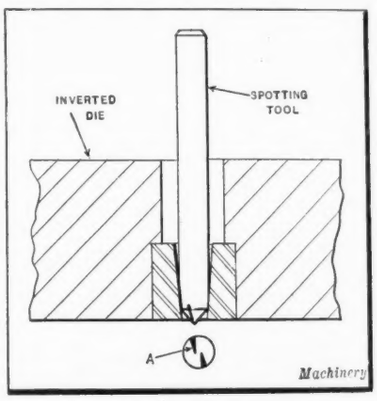
There is a tendency toward the use of longer railroad rails than have been used in the past. The prevailing standard is 33 feet, but recent orders for large tonnage of rails are for 39-foot rails. The reason for the use of longer rails is that joints of whatever type used constitute a heavy item of expense, both in respect to their first cost and their maintenance. Increasing the length of rails from 33 to 39 feet reduces the number of joints about 15 per cent.

SPOTTING TOOL FOR STRIPPERS AND PUNCH PADS

By ERNEST L. HOLCOMB

A spotting tool like the one illustrated has been found very useful in making piercing or piercing and blanking dies having round punches that are guided or supported by the stripper plate or the bushings in the stripper plate. In making dies of this kind, the die-block is machined first, and the hardened bushings set in place, after which the die-block is ground on both the top and bottom, ready for use.

The next step, assuming that the bushings are all of the same size, is to make a spotting tool like the one shown, from a short piece of drill rod which has a diameter a little larger than the bushing hole at the top of the die. The piece of drill rod is held in a drill chuck, and the end filed to a taper slightly less than the clearance taper in the die bushings, so that it will be guided by the bushing at a point near the cutting edge when inserted in the inverted die, as indicated in the illustration. The point of the spotting tool is filed to a sharper angle than the point of a drill, or to an included angle of approximately 90 degrees. Instead of having a flat at the extreme end like a drill, the spotting tool is required to have a sharp point. When the tool is inserted in the bushing, it must project slightly beyond the surface of the die.



Spotting Tool used in making Strippers and Punch Pads

The cutting lips in the spotting tool are produced by filing two or three gashes—depending on the size of the tool—on the conical end, as shown at *A*, care being taken to have the lips pass just in front of the center in order to avoid spoiling the point of the tool. These gashes are very shallow and can be easily made with a file if the spotting tool is held in an upright position in the bench vise. After being gashed, the tool is hardened and drawn just enough to relieve the hardening strains.

After the stripper plate has been doweled to the die-block with the nest plate or guide strips removed, the die-block and stripper are clamped in an inverted position on parallel bars while the punch-supporting holes in the stripper plate are located by means of the spotting tool inserted in the bushings in the manner indicated. A small quantity of oil is used on the spotting tool to prevent scoring the holes in the bushings. Before unclamping the stripper plate, the spots may be examined by holding the die-block so that the light will shine into the bushing holes. After the stripper plate has been spotted, it is mounted on the lathe faceplate and the holes bored, using a test indicator or what is generally termed a "wiggler" to line up the work.

The same spotting tool is used in a similar manner to spot the holes in the punch pad or holder. The punch-holder cannot, of course, be doweled to the die-block, but otherwise the process is the same as described. The stripper plate does not need to be a close fit for the punches of some dies, and in such cases only the punch-holder requires accurate spotting and boring. While the method described is of the greatest value in making dies having several bushing holes of the same size, it is nevertheless worth while in most cases to employ spotting tools when there are a number of different sized bushings in the dies. By placing the spotting tools in a rack after they are used a variety of sizes that will meet ordinary requirements is soon available.

Notes and Comment on Engineering Topics

An electric motor installed in a well on a ranch at Corona, Cal., was buried eight years ago when the well caved in. Recently the motor was removed from the well, cleaned, thoroughly dried, and was found to be in excellent condition in spite of the fact that it had been underground in damp earth for about eight years. The only repairs necessary were to replace the external leads, insulate some of the end connections, and varnish and bake the windings. The oil piping to one of the bearings had also rusted out and had to be replaced, and one of the ball bearings had to be replaced because of rust.

What is said to be the largest girder in building construction in the world has recently been installed in a new building in Buffalo. This girder weighs approximately 100 tons and is slightly over 100 feet long. It will support the entire weight of the balcony of the auditorium, which will seat 1000 people, and the load carried when the balcony is filled will be 1,100,000 pounds. The girder rests on two columns at the sides of the building, and its use removes all pillars or other obstructions underneath the balcony and also provides a very high factor of safety. At the center, the girder is 7 feet deep and 3 feet wide.

Several years ago some of the members of the American Foundrymen's Association concluded that standardization of certain foundry equipment would aid in reducing the cost of castings, especially when made by molding machines. Committees have now been formed for this purpose and efforts will be made to standardize patternmaking, pattern plates and mounting, flask sizes, and details of flask construction. On the committee engaged in this work the following associations are represented by two members each: American Foundrymen's Association, American Institute of Mining and Metallurgical Engineers, American Malleable Castings Association, American Society for Testing Materials, Foundry Equipment Manufacturers' Association, National Association of Pattern Manufacturers, National Association of Purchasing Agents, and the Steel Founders' Society.

Some interesting efficiency tests have been made on worms and worm-gears produced by the Daimler Co., Ltd., Coventry, England. The worm and gear tested had a center distance of 6 inches and a ratio of 9 to 34. These gears were tested by a special worm-gear testing machine at the British National Physical Laboratory. The accuracy of this testing machine for efficiency determinations is estimated to be within 0.2 per cent. In the tests made, efficiencies varying from 93.3 to 97 were recorded. Out of thirty tests, however, twenty-five showed an efficiency of over 96 per cent, and in three of the tests an efficiency of 97 per cent was reached. The speeds at which the tests were made varied from 230 to 1500 revolutions per minute, and the horsepower transmitted from 4.3 to 144.6. The higher efficiencies were recorded at the higher speeds when the greater power was transmitted.

We often hear references made to the horsepower capacity of large stationary steam plants. The locomotives of our leading railroads, with their enormous horsepower, however, are seldom thought of as power plants in the same way. According to the *Engineering News Record*, the horsepower of the steam and electric locomotives of the New York Central Railroad, comprising about 5 per cent of the total mileage of the railroads of the United States, aggregates 11,000,000, or about one-fifth of the total installed stationary horsepower reported by the United States Census in all of the other industries of the country. The New York Central Railroad, without doubt, has a larger locomotive horsepower in proportion to its mileage than the average for the country as a whole, but even if we assume that the New York Central lines have twice the horsepower per mile of road, as compared with the average for the entire country, we find that the total capacity of the steam locomotives of the railroads of the United States would be 110,000,000 horsepower, or more than twice as great as the capacity of all other power plants.

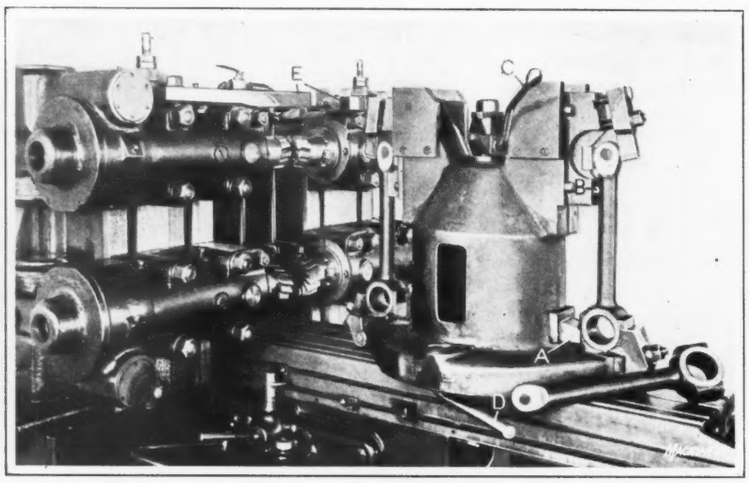
One of the well-known radio engineers of the country recently stated that the ordinary telephone did not take second place compared with the radio in regard to the really wonderful characteristics of the invention. "Suppose," said he, "that the radio had been invented forty or fifty years ago, but that the ordinary telephone had been unknown until this date. We would have had broadcasting, and we could have heard public speakers talk to us while we were seated comfortably in our homes. We could have received the news, heard concerts, the baseball score, and followed the prize-fights right in our own sitting rooms, but that would have been about all. Then somebody would have come along and said, 'I have got an invention whereby you can sit in your own home or office and you can pick out anyone of 5,000,000 people in the United States and you can talk to him at an instant's notice and he can answer you. And what is more, no one else will be able to listen in on the conversation.' Now, that would have been considered a really wonderful invention, if the order had been reversed."

A new cement intended for construction purposes has been developed under the name of "Lumnite" cement. This is a hydraulic cement, which is said to have, in addition to the desirable qualities of Portland cement, the property of developing, in twenty-four hours, a strength somewhat greater than that developed by ordinary Portland cement in twenty-eight days. In Europe, similar cements are considered especially suitable to resist the chemical attacks of sea water and sulphate bearing ground waters.

Lumnite cement is made by the Atlas Aluminate Cement Co. at Northampton, Pa., from raw materials including a large proportion of aluminum ore (bauxite). The raw materials are fused and then ground to a considerably greater fineness than the requirements of the standard specifications for Portland cement. This new cement is used in the same way as ordinary Portland cement, except that somewhat wetter mixtures should be used. The new cement should not be mixed with Portland cement, even in very small quantities, as this destroys the desirable properties of both materials.

The most interesting feature about "Lumnite" cement is that it attains so great a strength in the short period of twenty-four hours. It is stated that roadways, for example, laid one day, may safely be opened to traffic the following day; and bridges poured one day can have the forms removed and be opened to traffic two days later. In structural work, the forms may be removed and used for new sections in one-tenth of the time required for Portland cement. The cost of the new cement is higher per barrel than that of Portland cement, on account of the large content of high-grade aluminum ore, but this will in many cases be offset by the advantages of the new material.

Milling Automobile Truck Connecting-rods



Complete Tooling for Milling Operations on Connecting-rods for Mack Trucks, Designed and Made by the Cincinnati Milling Machine Company

By CHARLES O. HERB

SERVICE to the customer in the way of designing fixtures and determining the tool set-up for a given job has become almost a universal practice among machine tool builders. And this is not strange, because usually no one else is so well qualified to do this work as the engineering department of the machine tool builder. That department generally has records of similar jobs, and, of course, fully understands the possibilities of the machine. Also, when a concern builds a variety of machines for performing operations of the same or different classes, it is an easy matter to decide just which type and size of machine is most suitable for the job.

The tooling equipment designed by the Cincinnati Milling Machine Co. for performing the milling operations on connecting-rods for Mack trucks is described in the following. These connecting-rods are steel drop-forgings, and are machined all over. The various surfaces milled are clearly indicated by the heavy solid lines in the diagram, Fig. 3.

Milling the Piston-pin and Crankpin Bosses to Length

The first milling operation on the connecting-rod consists of milling both the piston-pin and crankpin bosses to length. This is done on a 48-inch duplex automatic milling machine equipped with four cutter-spindles and a two-position indexing jig, as shown in the heading illustration. It will be seen that the work is held vertically to permit milling both bosses at the same time. Shell end-mills are employed instead of straddle milling cutters which are more commonly used for operations of this kind. The reason for this is that with end-mills, the cutter diameters can be much smaller. Thus the cutter cost is less and the setting up time is lower, because it is not necessary to space the cutters on the arbors. The rod rests on a fixed support, and is located sideways by clamping the crankpin boss in a V-block *A* and the opposite end of the rod in a V-block *B*. The index base is clamped and unclamped simply by manipulating lever *C*, and it is indexed by means of lever *D*.

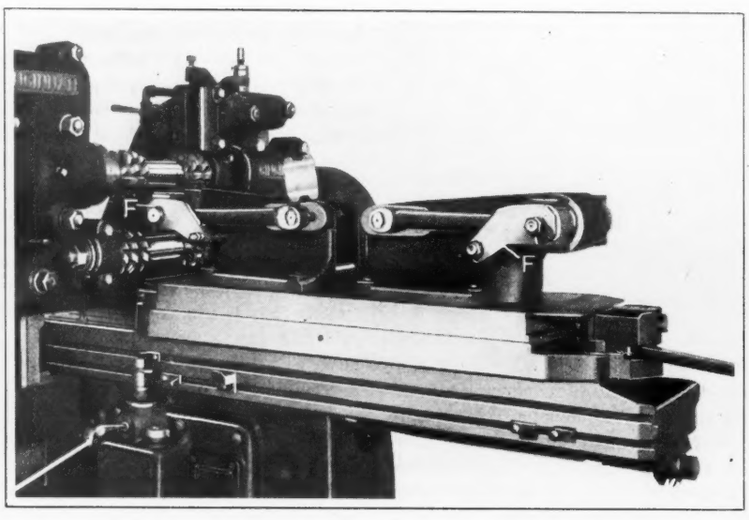


Fig. 1. Finish-milling the Bolt Lugs on the Crankpin End of the Connecting-rod

Five-inch cutters are mounted on the lower cutter-spindles for finishing both sides of the crankpin boss, and 3¾-inch cutters of special form, on the upper spindles for finishing the piston-pin boss. As the work is fed between the cutters, stationary guides *E* clamped to the upper spindle carriers bear against the finished sides of the advancing fixture and prevent the top of the fixture from vibrating under the cut. All four cutter-spindles are driven through worm-gearing, and each spindle is equipped with a quill which permits individual end adjustment. With a feed of 4⅜ inches per minute and cutter speeds of 66 and 80 revolutions per minute, respectively, the average production time is 1.28 minutes per piece, about 3/16 inch of stock being removed from each surface. Coolant is supplied copiously to the milling cutters during the operation.

Form-milling the Bolt Lugs

Bolt lugs *L*, Fig. 3, are machined from the solid in rough- and finish-milling operations, by the use of form milling cutters. With the exception of the cutters, the tooling equipment used in both operations is the same as that shown in Fig. 1, which illustrates the finishing operation. Both operations are performed on a duplex automatic machine, equipped with special cutter-arbors, outboard supports, and two fixtures mounted on a standard indexing base. Two connecting-rods are mounted hori-

zontally on each fixture. When the operation is completed, the movement of the table is automatically reversed until it reaches the starting position, at which time the fixture base is indexed to feed the work in the opposite fixture past the cutters. There is plenty of time during the milling for the operator to remove and replace the rods previously milled.

In the roughing operation, four form cutters with but a single ring of teeth are mounted on the two arbors for hogging out the metal between the bolt lugs on the top and bottom sides of the rods. Owing to the fact that these lugs are forged solid, considerable metal must be removed, and as the metal is tough, the operation is considered a severe test of the machine. The average time per piece in this operation is 1.42 minutes, using a 4½-inch cutter at a speed of 53 revolutions per minute and a feed of 3½ inches per minute.

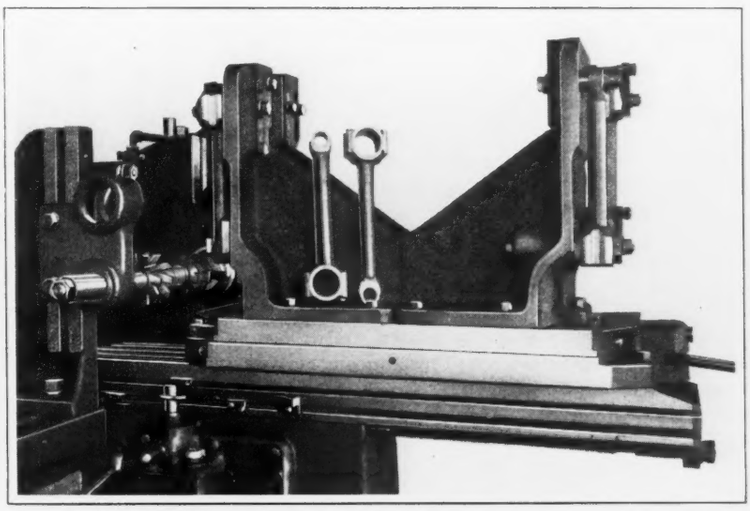


Fig. 2. Equipment for milling the Rounded Surfaces at Both Ends of the Rod

In the finishing operation, four form cutters having three rings of teeth, as shown, take a cut completely over each bolt lug and between them. These cutters have a nominal diameter of 4¾ inches and are used at the same speed as the roughing cutters, but at a feed of 4⅜ inches per minute. The production time per piece is 0.58 minute.

One advantage of milling with cutters above and below the piece is that the vertical pressure is neutralized, which reduces the wear and tear on the fixture and tools. The upper of the cutter-arbors is driven from the left-hand side, and the lower arbor from the right-hand side. For supporting the opposite end of each arbor there is a special outboard bearing. Before the rod comes to these operations, both the piston-pin and crankpin bearings are machined, and so the rod can be located in the fixture from these points. A full stud is entered into the crankpin bearing and a half stud into the piston-pin bearing. The rod is located sideways by means of the finished crankpin bosses, two swinging clamps *F* on each fixture being tightened by means of one bolt to hold both rods in position.

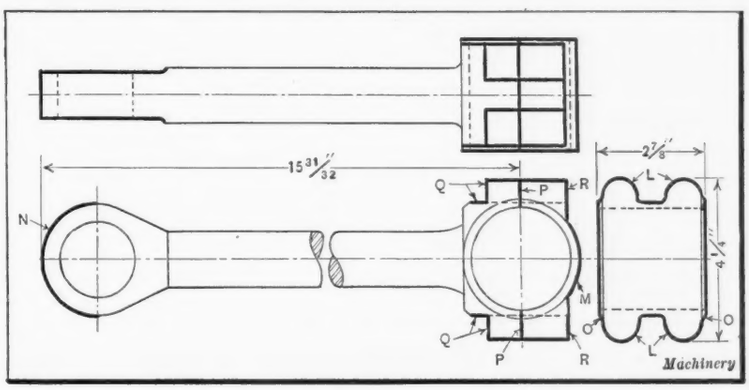


Fig. 3. Diagrammatic Illustration of a Mack Connecting-rod, in which the Heavy Solid Lines indicate the Surfaces finished by Milling

An important feature of the fixtures is that the small stud used to locate the piston-pin end of the rods is fitted in a slot in which it may be positioned to suit rods of different lengths. The same fixture can also be used for rods having different bearing diameters by using a bushing for the crankpin bearing and a different half stud for the piston-pin bearing. In both operations, an individual stream of cutting lubricant is supplied to each cutter.

The fourth milling operation consists of form-milling the rounded surfaces *M* and *N*, Fig. 3, on the two ends of the rod, and is performed on a plain automatic milling machine equipped as shown in Fig. 2. Two form cutters, 4½ and 5¾ inches outside diameter, are mounted on one arbor for finishing ends *N* and *M*, respectively. With a cutter speed of 53 revolutions per minute, a feed of 3½ inches per minute, and removing from ⅛ to ¼ inch of stock, the production time averages 1.3 minutes per rod. It will be seen that two rods are mounted vertically on the ends of the two fixtures, one with the piston-pin end down and the other with the crankpin end down. After the operation has been performed, the table is reversed automatically, the fixture base indexed, and the rods on the other fixture fed past the cutters. While this step is in process, the previously machined rods are reversed ready for finishing the opposite ends at the next indexing of the fixture base.

In this operation, the rods are also located on studs which pass through the crankpin and piston-pin bearings. Again, the fixtures are adapted for different lengths of rods by making the two upper studs adjustable vertically. In addition, the stud that engages the piston-pin bearing when the rod is held with the piston-pin end down is also adjustable vertically so that it is not necessary to grind the two form cutters in

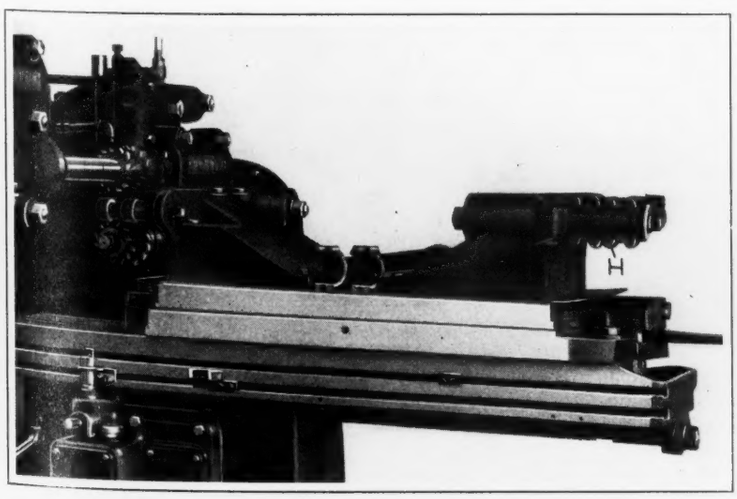


Fig. 4. Operation in which the Bolt Lugs are milled to Length and the Cap sawed off

relation to each other. The rods are held on the studs by simple strap clamps. These fixtures are comparatively heavy, but the base is easily indexed because the weight of the rotating portion is taken on a spring-supported ball bearing of large diameter. In this operation, the cutters are applied under the work in order to bring the operation close to the table and thus eliminate chatter.

The next operation consists of simultaneously profiling both sides of the crankpin boss, as indicated at *O*, Fig. 3. This is performed by means of equipment similar to that illustrated in Fig. 5. However, in this illustration a different rod from the one being considered is shown; on this rod there is only one bolt lug on each side of the crankpin boss, and this lug is centrally located. It will be seen that a special hand-fed circular milling attachment, carrying one rod, is mounted directly on the table of a vertical type machine. For locating the rod, the crankpin bearing is seated on a stud attached to bracket *G* and the piston-pin bearing on a half stud on the same bracket. The rod is clamped tight by means of a U-washer and nut on the crankpin end. The work is revolved the required amount past the cutters by simply turning the handwheel of the fixture, the movement of the work being limited by stops.

Two special form relieved cutters 5 inches in diameter, having alternate tooth angles, are mounted on a stub arbor

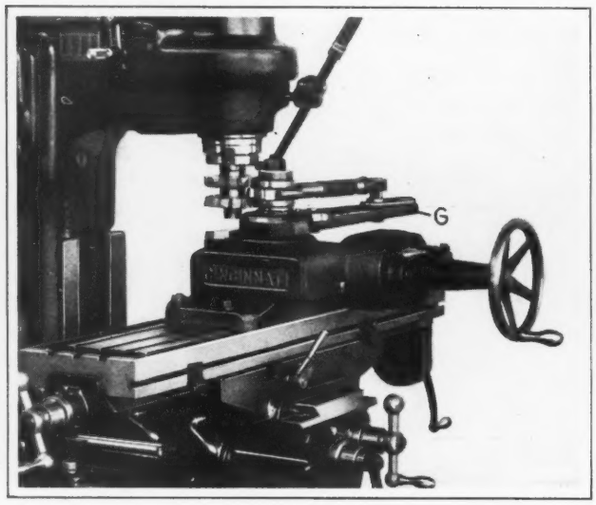


Fig. 5. Profile-milling Both Sides of the Crankpin Bearing Boss

for this operation. The average production time, removing from ⅛ to ¼ inch of stock, is about 2¼ minutes per piece. Rods of various lengths can also be handled in this fixture, the stud for the piston-pin bearing being mounted in a slot in which it can be adjusted relative to the stud for the crankpin bearing. The fixture is returned to the starting point by a rapid traverse gear, engaged by the lever shown.

Splitting and Straddle-milling the Crankpin End

Another duplex automatic milling machine is used in the sixth operation, which consists of sawing the cap from the crankpin end of the rod along lines *P*, Fig. 3, and of straddle-milling surfaces *Q* and *R*. In this case the machine is again equipped with a standard indexing base on which two fixtures are mounted, as shown in Fig. 4. Each of these fixtures supports two rods, side by side, in a horizontal position parallel to the cutter-arbors, as clearly seen at *H*. Three cutters are mounted on the overhead arbor, and the same number on the lower stub arbor, two rods being completed at each forward movement of the table. The upper arbor is supported at both ends, because, as it is driven from the left-hand side, it must extend the length of the rod. The rods are located on horizontal studs and held in position by swinging clamps. Three different lengths of rods can be accommodated in this fixture. In this operation, 5/32 inch of stock is removed from each end of the bolt lugs and a saw ⅛ inch thick is used for the splitting. With a cutter speed of 53 revolutions per minute and a feed of 3½ inches per minute, the average time per piece is about 0.9 minute.

Finish-milling the Joint Surfaces of the Rod and Cap

The final milling operation consists of finishing the joint faces of the rod and cap in a plain horizontal milling machine equipped with the two fixtures shown in Fig. 6. One cap and one rod are held in each fixture and milled as they are fed past a 6-inch shell end-mill. The rods are located by three centers, two of which bear between the bolt lugs on the top and bottom of the crankpin end, while the third enters a small center hole in the piston-pin end. The lower one of the centers on the crankpin end is spring-actuated, a positive up and down location being obtained from a stud which fits between the bottom bolt lugs and through which the center projects. The center for the piston-pin end is also spring-actuated. Thumb-screws *J* are tightened to lock the three centers after they have been positioned.

The caps are located for the operation by means of a fork which bears on the bolt lugs and pushes the caps against a locater registering with the crankpin bearing. The caps are clamped against their previously finished sides by means of a simple strap operated through thumb-screw *K*. In this operation, a cap and rod are reloaded in one fixture

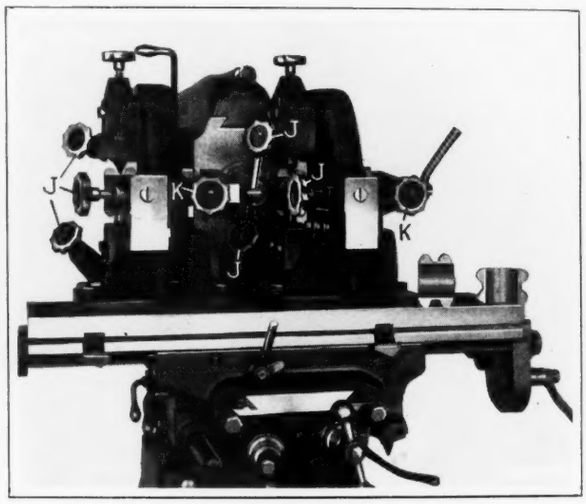


Fig. 6. Finish-milling the Joint Surfaces of the Rod and Cap

while the cutter is milling the two pieces in the other fixture. With a cutter speed of 61 revolutions per minute and a feed of 7 1/3 inches per minute, the production is one rod and cap every 1.05 minutes. The amount of stock removed is 1/64 inch.

This complete set of tooling equipment shows the service that can be rendered by the manufacturer of several types of machines, four different machines being used. In each case the machine is a standard one, merely provided with special fixtures, attachments, and cutter-arbors. By removing these, standard machines are obtained, which, of course, would have a higher resale value than special machines built for a single purpose.

* * *

THE "AMERICAN THERMAL UNIT"

To our surprise, some of our subscribers have taken seriously, the item on page 92 of October MACHINERY headed "An American Thermal Unit." We thought that it was quite obvious that the quotation from the Boston *Herald* was intended to be humorous. In the future, we shall avoid satire; and for the benefit of those of our subscribers who may still be under the misapprehension that this item was written seriously, we wish to disclaim any intention of advocating a change in the standard now universally accepted in all English-speaking countries for measuring heat values —the British thermal unit.

Special Milling Attachments and Fixtures

Examples of Milling on Standard Machines by Utilizing Attachments or Fixtures Designed for Unusual Milling Operations

By FRANKLIN D. JONES

SPECIAL attachments and fixtures for milling machines are sometimes employed to reduce the time for milling duplicate parts, and in other instances to make possible the performance of certain milling operations for which standard equipment cannot be adapted. The Brown & Sharpe Mfg. Co., Providence, R. I., has for many years given considerable attention to the development of milling machines and their auxiliary equipment, and a number of unusual examples of milling attachments and fixtures designed by this company are shown in this article. These examples illustrate the almost limitless possibilities of milling machines when properly equipped to meet manufacturing conditions. Some of these devices are designed for a specific operation, which indicates that the number of duplicate parts to be milled is large enough to warrant using a special appliance. Others that are shown, by making certain changes or adjustments, may be applied to a limited range or variety of operations of the same general type. Some of these attachments are classed by the manufacturer as standard rather than special, as they are regularly manufactured.

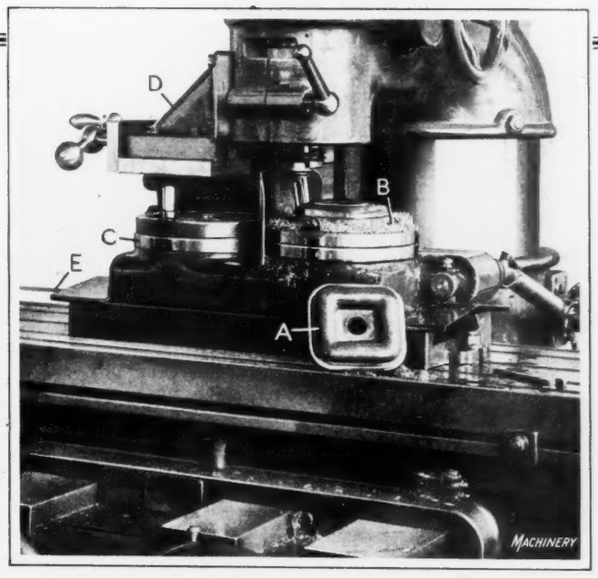


Fig. 1. Duplex Rotary Type of Attachment applied to Profiling

Converting Hand Milling Machine into Three-spindle Machine

For short milling operations, which require frequent insertion and removal of the work, the advantages of hand-operated milling machines are apparent, especially as applied to small parts. Such machines, however, are ordinarily used for comparatively simple operations, and special attachments are not needed for the bulk of the work done on them. An exception is shown in Fig. 2, which illustrates a hand milling machine set up for end- and straddle-milling of small brass spindles. Opposed end-mills are held and driven by the main spindle and by the attachment, respectively, and serve to form flats *A* on opposite sides of the central portion of the spindle. Flats are also milled on one end by the straddle-mill *B*, which is driven by the attachment.

The attachment has an independent belt drive to spindle *C*, which carries the pulley and from which power is transmitted to the straddle-milling cutters and end-mill. The straddle-mill spindle is supported by an arm, which may be swung about spindle *C* to obtain vertical adjustment. The work is clamped to the fixture by a single lever, so that the entire operation of milling, unloading, and reloading is performed quickly, the rate varying, of course, with different operators.

Swinging Type of Profiling Attachment

Profiling operations, or the milling of irregular outlines by using a master templet for controlling the path followed by the milling cutter, are usually applied to rather small surfaces, such as may be finished readily by end-mills or

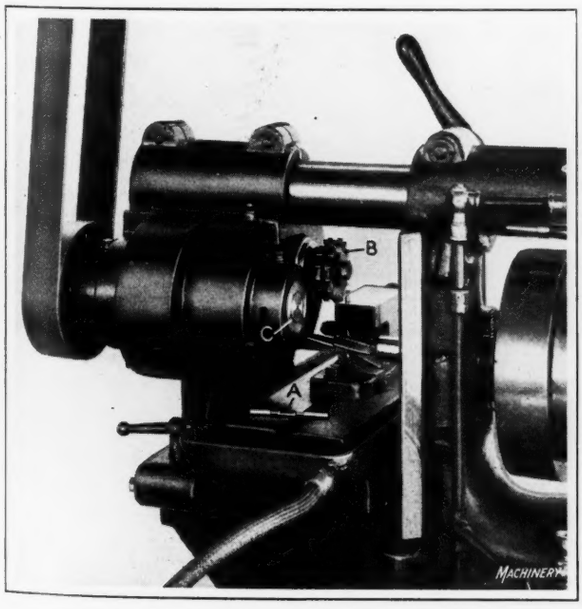


Fig. 2. Duplex Cutter-spindle Attachment applied to Hand Milling Machine

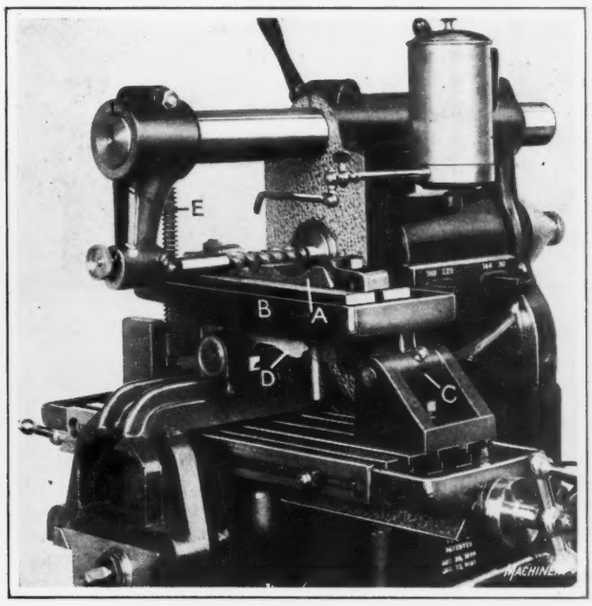


Fig. 3. Profiling Fixture of the Swinging Type, controlled by Master Templet

other small cutters held in the vertical spindle of a regular profiling machine. The profiling operation illustrated in Fig. 3 is unusual, owing to the size of the part and the width of the irregular surface to be milled. The special attachment for holding and controlling the movement of the work *A* has a work-table *B*, which is pivoted at one end *C*. Attached to the under side of the work-table is a master templet *D*, or former, which has the same contour as is required for the work but in reverse order, the concave sections of part *A* being duplicated by convex sections on *D*. The latter rests on a roller which has roller bearings at the ends and is supported by a bridge-shaped bracket mounted on the knee, so as to clear the main table of the machine.

The templet *D* is held firmly in contact with the roller by spring *E*, which acts downward against the free end of the work-table. This free end of the table is supported against lateral deflection by guides, as shown. As the main table of the machine feeds in a lengthwise direction, templet *D* passes over the roller, thus causing the attachment table and work to swing up or down, so that the part is milled to the required outline. The helical mill used has cutting edges that incline about 60 degrees from the axis, thus providing a smooth continuous cutting action.

Rotary Profiling Operations

Profiling operations requiring combined rotary and rectilinear motion for generating the required form are illustrated in Figs. 1 and 4. A standard design of vertical-spindle milling machine is used for this work. The operation shown in Fig. 1 is that of milling the edge of a boiler hand-hole plate *A*. This plate is held in fixture *B* by four bolts which grip the edge of the flange. Table *C* of the attachment holds the master cam, which has a groove corresponding to the shape of the edge of plate *A*. The roller, which engages this cam groove, is held by a special bracket *D* having an adjustable slide for locating the roller the correct distance from the spiral end-mill which finishes the edge of the plate.

When the machine is at work, both circular tables rotate in unison, motion being transmitted to them through a chain drive at the rear, in conjunction with a telescopic shaft having universal joints, and bevel and worm gearing. As the

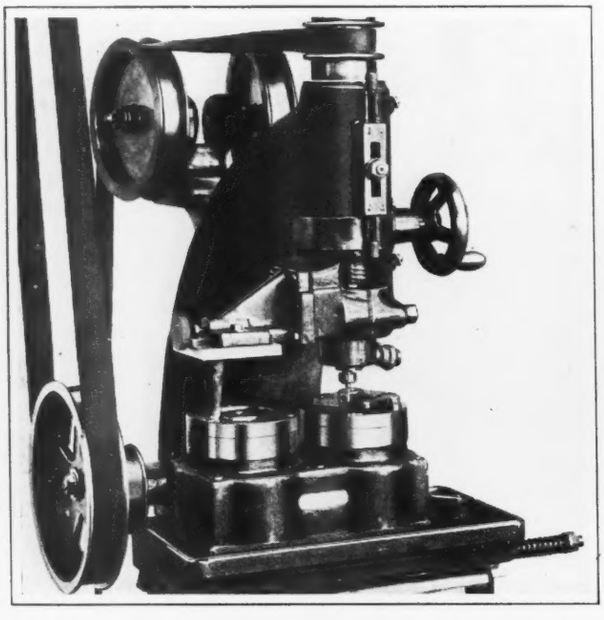


Fig. 4. Another Example of Profiling on Machine equipped with Duplex Attachment

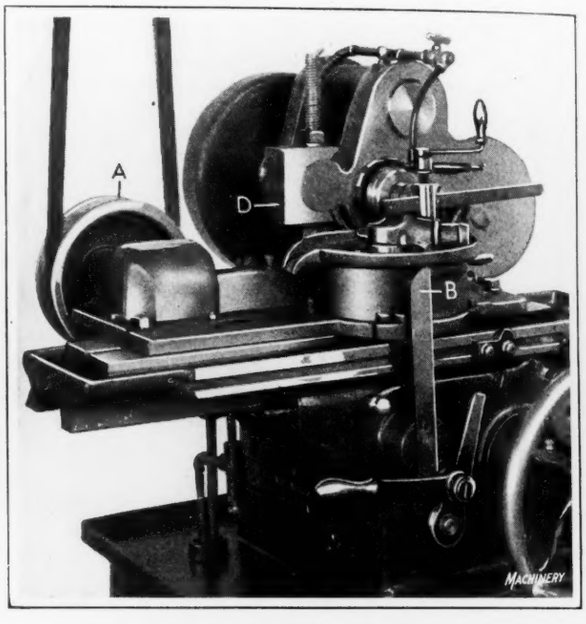


Fig. 5. Circular Milling Attachment for milling Projection on Air-brake Coupling

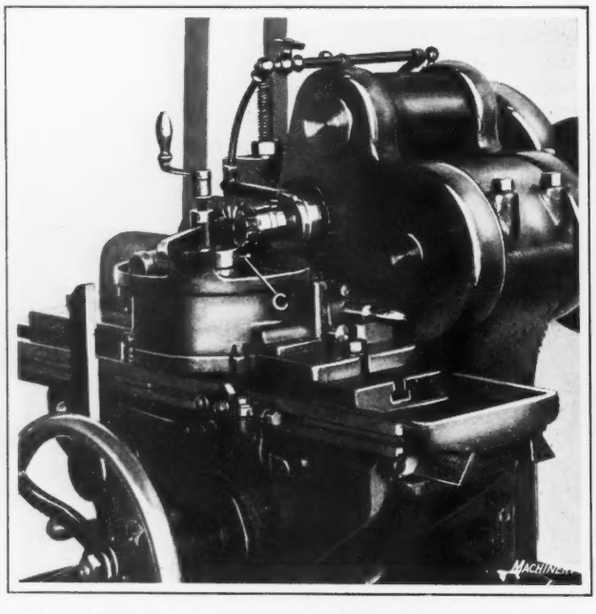


Fig. 6. Another View of the Circular Milling Attachment illustrated in Fig. 5

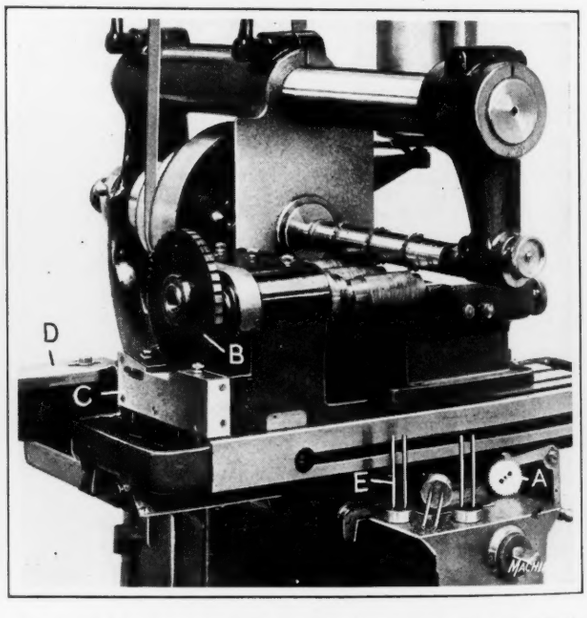


Fig. 7. Triple Automatic Indexing Attachment for cutting the Teeth of Clock Gears

master cam revolves while engaged by the fixed roller, the slide of the attachment moves to and fro upon its base; consequently, the combined rotary and sliding movements cause the shape of the cam to be accurately reproduced on the work. In order to maintain proper contact between the cam and its roller and prevent errors due to backlash, a weight is attached to a cable *E* connecting with the left-hand end of the slide.

The profiling operation shown in Fig. 4 is performed by using a duplex rotary type of attachment similar in general arrangement to the one just described, except that the master cam and work-tables are rotated by an independent belt drive. The belt pulley at the left is mounted on a shaft carrying worms which engage worm-wheels driving the table spindles. Proper contact between the master cam and roller is maintained by the use of a helical spring located at the right-hand end of the slide, this spring serving the same purpose as a weight.

Circular Milling Attachment

The form-milling of circular segments on castings for air-brake couplings is done by using the special circular milling attachment shown in use in Figs. 5 and 6. This attachment is driven independently by a belt connecting with pulley *A*, Fig. 5. The drive from this pulley to the work-table is through bevel gears and worm-gearing, the latter being located in the base of the attachment. A circular edge or ridge on the segment-shaped projection *C*, Fig. 6, is the part that is milled. The fixture and work swing about a vertical axis, and at the end of the cut the engagement of a trip-dog throws the worm out of mesh. The work-table is then swung back by hand to the starting position, the end of the return movement being arrested by a fixed stop *B*, Fig. 5. This attachment is used on a manufacturing type of milling machine. The table is mounted directly on the bed, and vertical adjustment for the cutter-spindle is obtained by raising or lowering block *D* along the screw shown, thus swinging the cutter-spindle housing about its pivot bearing at the right.

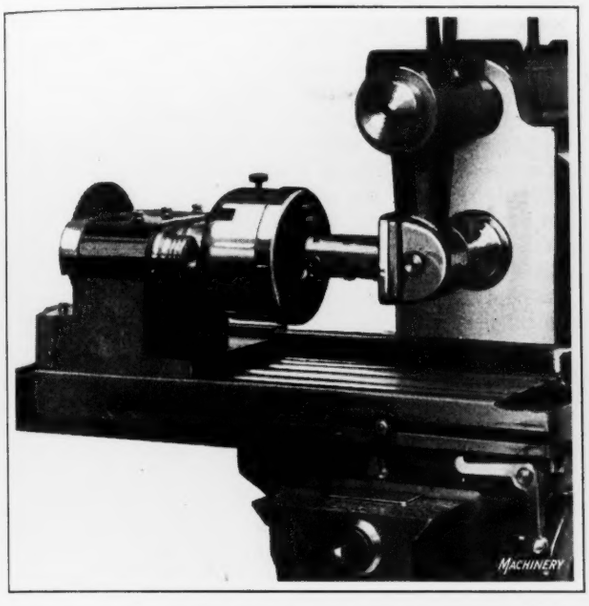


Fig. 8. Machine illustrated in Fig. 7, arranged for milling Small Internal Gears

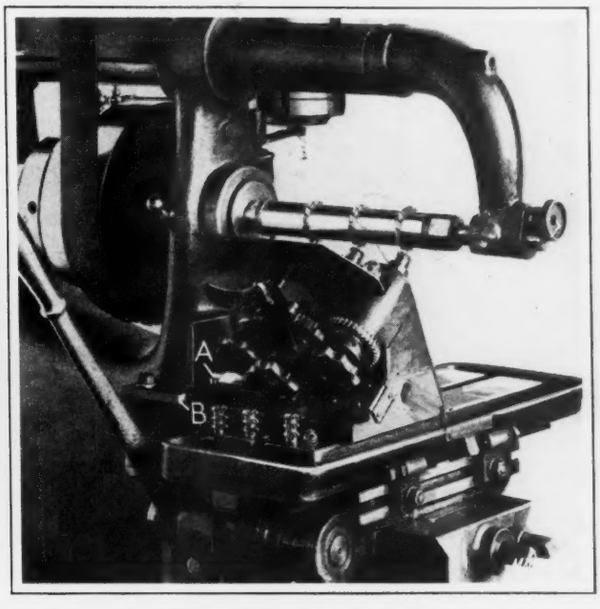


Fig. 9. Hand Milling Machine equipped with Triple Automatic Indexing Fixture for milling Small Bevel Pinions

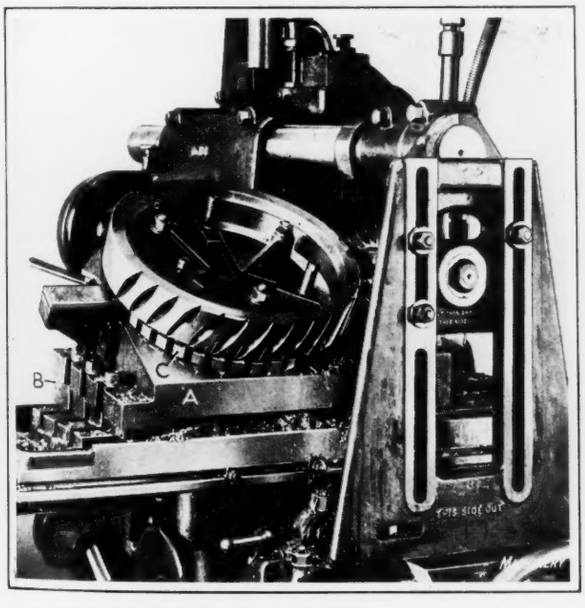


Fig. 10. Machine equipped with Rigid Fixture for holding Worm-gear Blanks while gashing

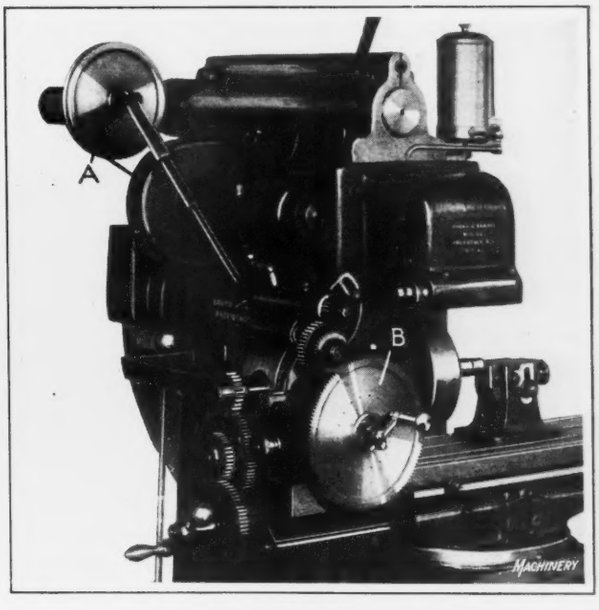


Fig. 11. Short-lead Attachment which drives the Work from the Main Spindle of the Machine

Attachments for Milling Instrument Gears

A three-spindle work-holding fixture for milling clock gears is shown in Fig. 7. A sample gear may be seen at *A*. These gears have 42 teeth of 27 diametral pitch, and three

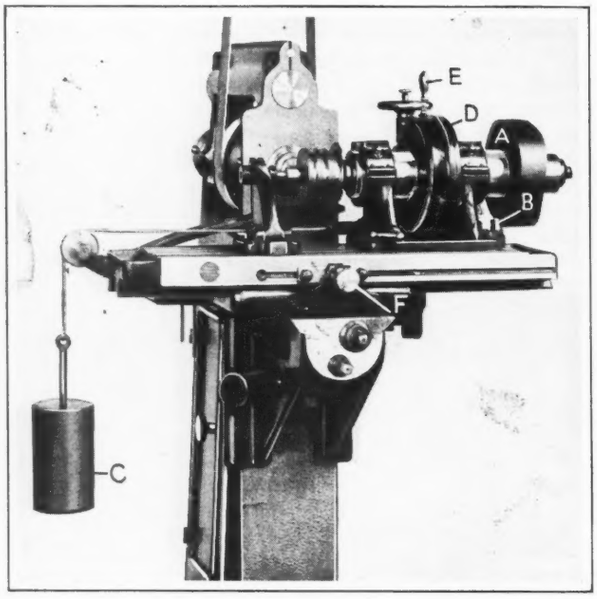


Fig. 12. One Form of Attachment for milling Cylindrical Cams

stacks are milled simultaneously by using three formed cutters. The indexing of the three work-spindles is automatically controlled. The two outer spindles are geared to the central spindle which carries at one end index-plate *B*. Beneath this plate in block *C* there is a horizontal slide containing a vertical roller which is held by a spring against plate *D*. This plate or operating cam is beveled at the right-hand end. The illustration shows the beginning of the cutting stroke. The table moves far enough to the right to mill tooth spaces across the stacks of gear blanks, and the cutters pass through these spaces during the return movement. Just before the end of the return stroke, the roller of the slide in block *C* engages the beveled edge of fixed plate *D*, and the slide is pushed into block *C*.

This movement of the slide serves to remove a locking plunger from the index-plate, and a pawl for indexing. As the table reverses for the cutting stroke, the slide in *C* also reverses, moving back along the inclined edge of plate *D*, indexing the work-spindles, and allows the locking plunger to engage the index-plate again before the cutters begin to work. The special arbors *E* used for holding these gears, have two pins which pass through holes in the gear blanks.

Fig. 8 shows an attachment for cutting internal gears which are to mesh with the smaller external gears just referred to. The fixture shown in Fig. 7 is adapted for this operation by mounting a chuck on the center spindle. The cutter is held at the end of a projecting arm, and is driven through a train of small spur gears. The automatic indexing attachment referred to in connection with Fig. 7 is also used for cutting these internal gears.

The application of a hand milling machine to the cutting of small bevel pinions is illustrated in Fig. 9. This fixture has three spindles, which are inclined to the correct cutting angle, and are indexed automatically by utilizing the same fixed plate and slide mechanism described in connection with Fig. 7. The roller attached to the horizontal slide may be seen at *A*, and the fixed plate with the beveled edge is located at *B*. The milling cuts are very short in this case, so that the hand-lever feed for the table is considered preferable.

Worm-wheel Gashing Fixture

The usual method of gashing a worm-wheel in a milling machine, preparatory to hobbing, is to place the wheel on an arbor held between the centers of a dividing head. In order to obtain greater rigidity and reduce the time for gashing blanks on a quantity basis, the fixture shown in Fig. 10 was designed. This fixture has an angular base *A* which holds the worm-wheel at an angle corresponding to the inclination of the worm thread. The removable plate *B* provides means of changing this angle, if required, for a different lot of worm-gears. The notched plate *C*, in conjunction with a lever-operated plunger, provides rapid and accurate means of indexing. The gashing cutter is mounted on an ordinary machine arbor. The rigidity of this fixture and the convenience of operation are apparent from the illustration.

Milling Helical Grooves Having a Short Lead

In cutting screw threads or helical grooves of long lead in an engine lathe, it is well known that the gearing is subjected to severe stresses because of the high ratio of gearing required to traverse the carriage a distance per revolution of the spindle, equal to the lead of the groove being cut. The same difficulty is encountered in milling helical grooves, but in the case of the milling machine it is the short leads that impose severe stresses upon the change-gears. This is due to the fact that the milling of a short lead requires a comparatively rapid rotation of the work, since the latter must make one revolution while the table is traversing a distance equal to the lead. Attachments are made for both lathes and milling machines which are designed to overcome this difficulty.

A Brown & Sharpe short-lead attachment is shown in Fig. 11 applied to a milling machine. Although this attachment is not new, doubtless many readers of MACHINERY will be interested in its general arrangement. The plan, in brief, is to drive the worm-shaft of the spiral head from the main spindle of the machine, instead of from the slowly revolving feed-screw, as is done ordinarily. The feed-screw is disengaged from the power feed mechanism while using the short-lead attachment. A small grooved pulley on the main spindle drives pulley *A* through the medium of a round belt, and from pulley *A* motion is transmitted to the large gear *B* through a telescopic shaft, universal joints, and change-gears. As the speed of the main shaft is fairly high, the last gear *B* in the train may be large, as shown, which reduces the stresses proportionately. If the drive were from the feed-screw, it would be necessary to use large driving and small driven gears, thus greatly increasing the stresses in the gear teeth.

The ratio of change-gears connecting with gear *B* determines the speed of rotation of the work, and the lead is controlled by another set of change-gears connecting the spindle of the spiral head with the feed-screw. This is the train of gears seen at the left in the illustration. With this arrangement, the rotation of the work is independent of the feed-

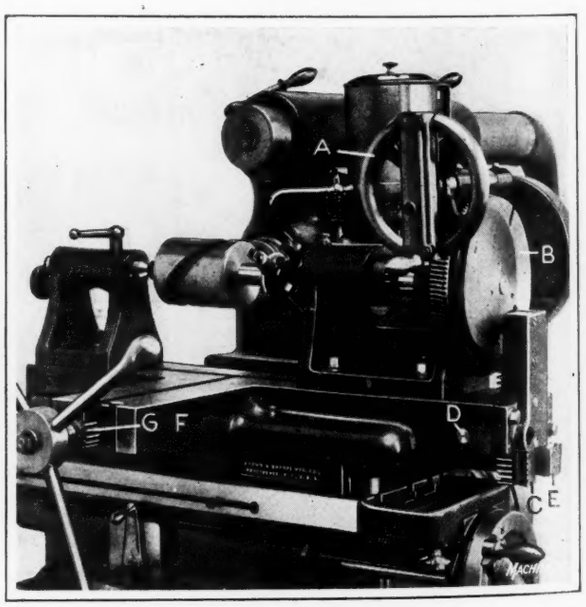


Fig. 13. Cam-cutting Attachment designed for cutting either Cylindrical or Face Cams

screw, and the latter rotates with and is driven from the work-spindle.

Cam Milling Attachments

Most cams are milled by using either an attachment or a special cam cutting machine, the arrangement in either case being such that the contour of a master cam or templet serves to control the curvature of the cam groove that is milled. The curvature of the master cam groove or templet may or may not be an exact duplicate of the cam that is cut, as this depends upon the design of the cam-cutting mechanism. The attachment shown in Fig. 12 is adapted for cutting cylindrical cams. The particular design of cam shown in the illustration has two grooves of different shapes, the cam being a duplex type. The master cam *A* on the end of the work-spindle engages a fixed roller *B*, and is held in contact with this roller by weight *C*. The work-spindle is rotated from the rear through a telescopic shaft with universal joints, in conjunction with bevel gears and large worm-gearing in housing *D*. Provision is made for disconnecting the drive, the handwheel *E* on the worm-shaft providing hand adjustment. The work-spindle is free to slide within its sleeve, but the worm-gearing does not move in a lengthwise direction.

When the machine is in operation, the work-spindle is traversed to and fro as the edge of the master cam *A* rotates in contact with the fixed roller *B*. The curvature of the edge of the master cam corresponds to that of the cam groove, although on a larger scale. For milling the second groove, the master cam is reversed, thus locating the opposite edge in contact with the roller. The main table of the machine remains in one position while milling one of the cam grooves. For milling the other groove, the table is relocated the right amount by engaging the plunger *F* with a second hole in a locating plate attached to the front edge of the table.

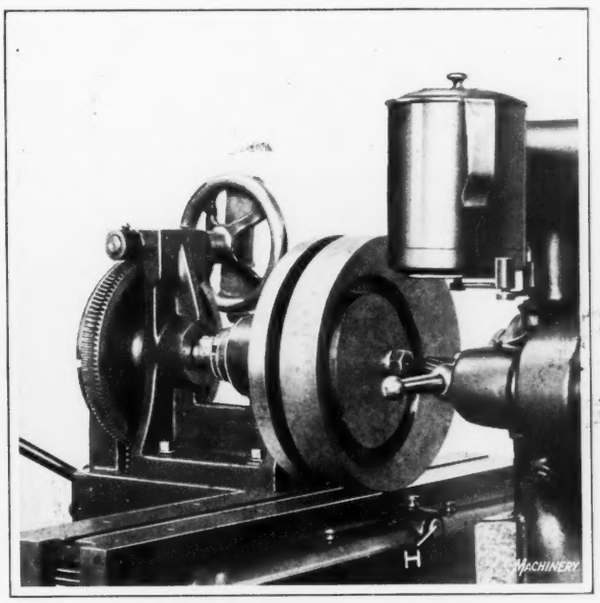


Fig. 14. Cam-cutting Attachment shown in Fig. 13 set up for milling a Face Cam

An attachment that may be used for cutting either cylindrical or face cams is shown in Fig. 13, this particular illustration representing the arrangement for cylindrical cam cutting. The work-spindle is rotated by handwheel *A* through worm-gearing, although a belt drive is sometimes used. The flat former or master cam *B* rotates with the work-spindle, and is in contact with a roller attached to the vertical rack *C*. The vertical movements thus imparted to rack *C* cause a pinion on shaft *D* to roll along a fixed rack *E*, thus traversing the work-holding table of the attachment at a rate depending upon the contour of the master cam. The cam groove is cut by an end-mill located at the same height as the cam axis.

If a face cam is to be cut with the attachment just described, the headstock is placed on extension *F*, and the vertical rack *C* then engages pinion *G*. Fig. 14 shows the attachment set up for milling a face cam. It will be noted that this cam is bolted directly to the end of the spindle. The flat form of master cam is used either for face or cylindrical cam milling. As the vertical rack at the front is moved up and down by the master cam, pinion shaft *H* is rotated and with it a pinion which transmits motion to the work-table.

No attempt has been made in this article to cover the general subject of milling attachments, as there are numerous designs ranging from many well-known standard types to very special attachments designed for specific operations. The few examples given are intended to illustrate how milling machines designed for general work, may, in effect, be converted temporarily into special types.

* * *

PUTTING THE COLLEGE GRADUATE TO WORK

By E. H. FISH

Many employers would like to get some new blood by hiring a few college men, but their superintendents do not all know how to get any real value out of them. Even superintendents and works managers who are engineering graduates themselves have been out of school so long that they do not quite appreciate the possibilities and the limitations of these men.

Let us see what a college man has to offer: First of all he is of the student type, although some of the men down the line, far from the "honors," are not so much of this type. Second, his habits of industry are not adapted to the fixed hours of the shop. He may have worked and studied longer hours than men work in shops, but he has chosen his time for study to a considerable extent. If he has preferred to play tennis in the afternoon and study past midnight, it has been his privilege. It takes time for him to adapt himself to a regular routine. He is also accustomed to expressing his own thoughts. It is a new idea to him that he may better become a coincider—a "Yes man."

Colleges try to teach their graduates to *think*. Manufacturers want them to *do*. There is quite a transition involved in going from a thinking part to an acting part. In college, they have had some shop practice, some laboratory work, some drawing, but none of it has been on a production basis; little if any has been against time.

When the newly graduated engineer goes into the shop, he has then to learn to keep his mouth shut, and to work regular hours. If the superintendent or his foremen understand that it takes time for the new man to form habits, and that the formation of these habits to a certain extent counteracts the lessons he has been taught, there is more chance of success with the young man.

As it is, nine out of ten of these boys land on their feet, not at once, but ultimately. During the transition period they are often not worth the little that it is necessary to pay them. They might be worth that much, and very possibly more, if employers would give them the consideration that they do a new machine when they are breaking it in. Any one who bought a new motor car and then tried out the engine by giving it impossible things to do would soon discover what a new engine costs; and yet the unnecessary cost of breaking in college graduates will likely average quite as much as the cost of a new engine.

* * *

According to the Bureau of Census there were thirteen manufacturers engaged in making motorcycles in 1923, the number produced being 41,894, valued at over $10,000,000. Of the thirteen factories three are located in Ohio, three in New York, and seven in Connecticut, Illinois, Massachusetts, Michigan, Pennsylvania, and Wisconsin.

Machining Balls and Sockets

By W. R. GRAHAM

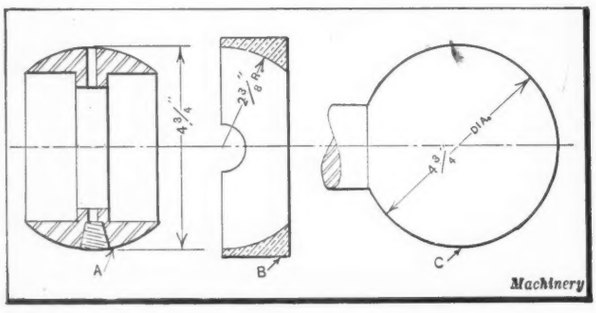


Fig. 1. Work turned by the Use of Fixture shown in Fig. 6

ONE of the most interesting jobs with which the writer has ever come in contact was the machining of interchangeable cast-steel balls and bronze sockets for use in the construction of electric commercial trucks. The balls and sockets were made in two different sizes, namely, 4¼ and 4¾ inches in diameter, respectively. At *A*, Fig. 1, is shown one of the cast-steel balls, and at *B*, one-half of a bronze socket. Both the ball and the socket were turned by the use of the lathe attachment shown in Fig. 6. At *C*, Fig. 1, is shown a plain steel ball turned on the end of a piece of shafting to illustrate the adaptability of the ball-turning device for ordinary spherical turning. The special chuck employed to hold the half-sections of the bronze sockets is shown in Fig. 5.

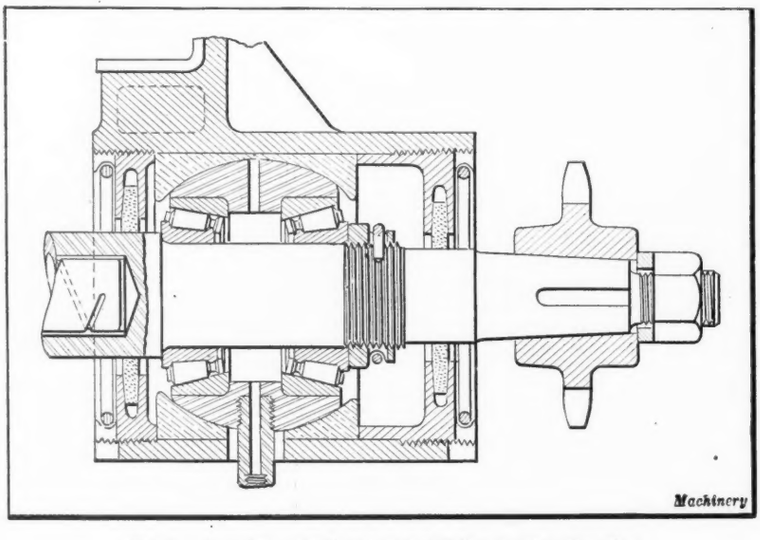


Fig. 2. Assembly of Ball and Socket Roller Bearing Mounting

The tools originally employed to form the spherical surfaces of the balls and sockets are shown in Fig. 3. With these tools, three settings were required to machine each ball, and at least two and generally more to machine the sockets. With this method of machining, considerable time and skill on the part of the operator was required in order to obtain a good fit between the ball and the socket. As the original methods proved unsatisfactory, an attempt was made to secure a ball-turning device, but all the types available were rejected because they were not adapted for turning both the ball and the socket. A large number of balls and sockets were to be made, so it was decided that it would pay to develop a lathe attachment that could be used for turning both convex and concave spherical surfaces having diameters as great as 5 inches.

After obtaining some good suggestions from the machine operator and the foreman of the shop, the writer designed the attachment shown in Fig. 6, which is intended to replace the compound rest. The only machine work required in fitting the attachment to the lathe was to drill and tap four holes at the side of the cross-carriage for the purpose of securing the worm-shaft bearing brackets *A* and *B*. The handwheel shaft bearing bracket *C* is held in place by means of bolts located in the T-slot on the top of the main carriage at the front right-hand side.

The plate *D* is made of cast iron, and has T-slots cast in its face, as indicated in the illustration. This plate is centered on the cross-carriage by a stud *E* having a diameter of 1 inch, and which is a driving fit in the plate. The projecting end of this stud is a running fit in the hole in the cross-carriage originally provided for the stud of the compound rest. Plate *D* is held down by four special shouldered round-head cap-screws *F* which are fitted in the circular T-slot *G* in the top of the carriage *H*. The lower part of plate *D* is turned to a diameter of 9 inches, which is the same as the width of the cross-carriage. The turned down portion of the plate fits the ring worm-wheel *J*, which is also made of cast iron and machined to a driving fit on the plate hub, where it is keyed in place by four ⅜-inch headless set-screws *K*. It will be noted that the outer edge of plate *D* extends over the worm-wheel so that the worm and the worm-wheel are protected from chips. The worm *L* has a right-hand, single thread of ½ inch circular pitch and an outside diameter of 1.508 inches. This worm is operated by an 8-inch handwheel *M*, which is so positioned that it can be conveniently controlled by the operator's right hand. It will be seen from an inspection of Fig. 6 that the ordinary lathe toolpost can be mounted on plate *D* in various positions, a feature which provides for turning either balls or sockets.

The arbor *A* in the upper view of Fig. 4 is used to hold the Timken roller bearing mounting *B* when machining the ball or spherical surface. The fixed collar *C* and the clamping collar *D* are accurately machined to fit the inside bores of the mounting *B* so that the roller bearing seats will be in accurate alignment with the spherical surface. The bearing mountings are machined from rough steel castings, the bearing seat at

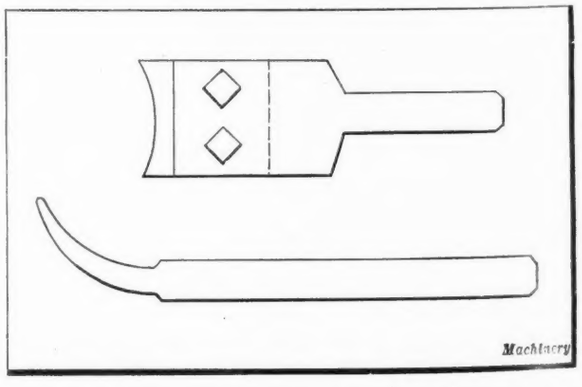


Fig. 3. Tools originally employed in turning Balls and Sockets

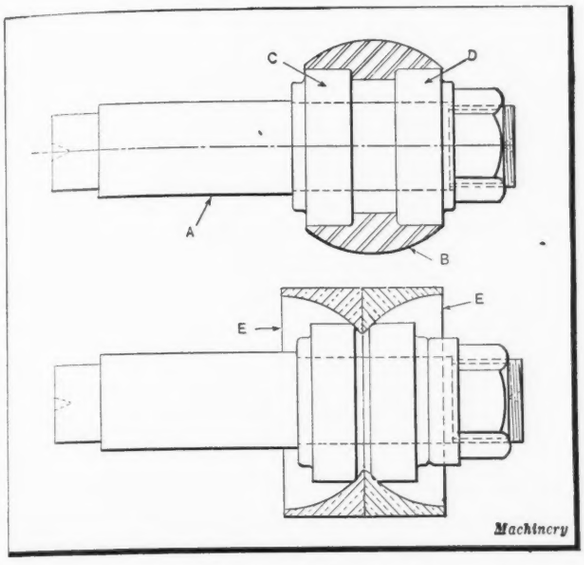


Fig. 4. Arbors used to hold Parts of Ball and Socket Bearing Mounting

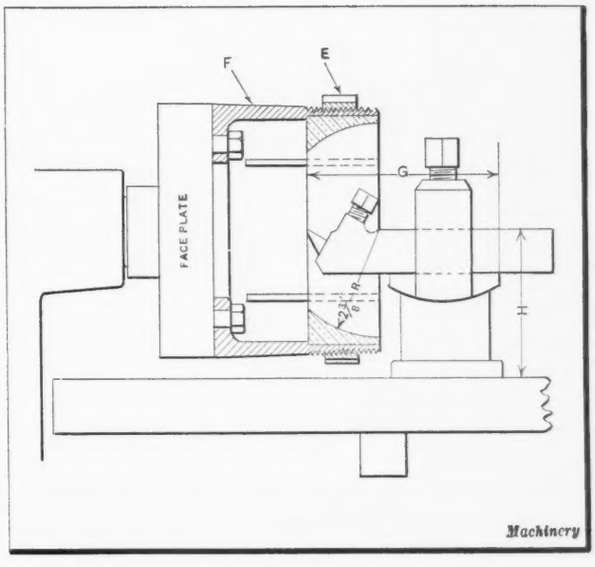


Fig. 5. Special Chuck for holding Sockets when turning

one end being first finished to size, after which the casting is turned around in the chuck and trued up with an indicator before finishing the other seat.

The same arbor *A* is also used for holding sockets *E*, as shown in the lower view of Fig. 4, when finishing the outside true with the center or concave spherical surfaces after the latter have been finished. The method of clamping the sockets on the arbor is clearly shown in the illustration and should need no further explanation. The special chuck used to hold the sockets when turning the spherical surface is shown in Fig. 5. The collet or chuck body *F* of this fixture is split in three places from the outside to the flange and is tightened on the work by turning up the clamping ring *E* which fits the tapered thread on part *F*. A spanner wrench which fits the slots cut in ring *E* is used in clamping or releasing the work.

The assembled ball and socket is used in a self-aligning countershaft of a chain-driven electric truck, the method of assembling being clearly shown in Fig. 2. The object of this design is to allow the torsional or bending strain of the shaft, due to the pull on the countershaft sprockets, to pass through the countershaft box flexibly instead of putting a rigid strain on the shaft at this point. It was found that the use of the spherical turning fixture and the special arbors described cut down the time required in machining a ball about twenty minutes, and that of machining a socket, about ten minutes over the "cut and fit to master gage" method. It was also found that the spherical surfaces were more accurate when machined with the improved equipment.

* * *

In 1923, Germany imported industrial machinery to a value of $763,500 from the United States, while in 1913 she bought $5,259,500 worth. In the latter year Germany was the third best customer for American machinery, being surpassed only by Canada and the United Kingdom, and in 1923 she was twenty-third.

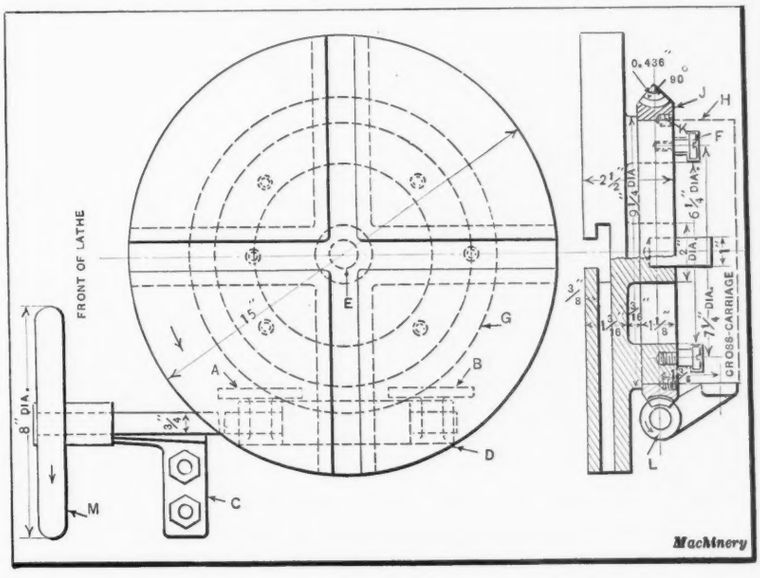


Fig. 6. Rotary Tool-holding Lathe Attachment used for Spherical Turning

THE TEXTILE MACHINERY INDUSTRY

A preliminary report of the Bureau of Census of the Department of Commerce relating to the census of manufactures for 1923 shows that the establishments engaged primarily in the manufacture of textile machinery reported products valued at $131,818,100, an increase of 2.2 per cent over the value of the products of this industry in 1921, the last preceding census year. Massachusetts, the leading state in the textile machinery industry, produced 44.7 per cent of the total; Pennsylvania, 16.2 per cent; and Rhode Island 14.4 per cent. The combined output of textile machinery reported by plants in these three states amounted to more than 75 per cent of the total production of the industry.

Of the 427 plants reporting to the Department of Commerce, 136 were located in Massachusetts, 70 in Pennsylvania, 56 in New Jersey, 51 in Rhode Island, 24 in New York, 17 in Connecticut, 14 in North Carolina, and 13 in Georgia; the last two figures indicate how the southern states are gradually entering into the field of textile machinery building. The average number of wage earners in this industry in 1923 was about 33,000 and the wages paid about $43,000,000.

* * *

The ten countries that offer leading markets for American automobiles are given in *Commerce Reports* in the order of their importance as importers of passenger automobiles as follows: Australia, Canada, Argentina, United Kingdom, Spain, Mexico, Sweden, British South Africa, Cuba, and Belgium. In the commercial motor truck field, the order of the leading importers of American motor trucks are as follows: Japan, Australia, Canada, Belgium, United Kingdom, Mexico, Sweden, Cuba, Spain, and Norway. Altogether in 1923, 87,500 passenger cars and 18,900 trucks were exported—an increase of about 25 per cent over 1920.

Setting Premium Rates

How Premium Rates can be Determined in Plants not Engaged in Quantity Production

By P. J. REES

PREMIUM or piece-work payment systems for machine shops are usually associated with plants manufacturing on a quantity basis, where special tools and fixtures are used and each operation can be carefully studied to determine standard times or rates. With such conditions it is a simple proposition to establish some form of wage incentive plan that will work satisfactorily to the management and the men, if administered by executives who try to play square. But what about the concern that manufactures a varied line of products with little repetitive work? There are many such plants where a high degree of standardization is impossible because of engineering problems peculiar to a particular plant, which require special designing, and because duplicate jobs are rarely booked. There may be a multitude of individual pieces of various sizes that make up the finished unit, but, even though there is a marked similarity in these parts between units, they will be far from duplications. With such parts there is a continual variation in the time required for machining them.

It is at once evident in dealing with a plant of this type that time study, with the idea of formulating standard time or piece-work schedules, is out of the question. Also, the necessity of continually setting new rates to suit the work in hand appears so difficult and hazardous that many times the proposition is abandoned without a trial. However, the need for the stimulating effect of a wage incentive system is even greater in the jobbing shop than in the shop producing a standard line, for with a new and untried piece of work the operator, if so inclined, can easily consume excessive time in machining it without arousing the suspicion of the foreman, as the foreman can only roughly estimate the time required, when there is no previous performance record to be guided by.

DATE 3-26-24 START → Hrs. Mi. 3-26-9 20
30 MACH. SHOP C STOP → O.T. Hrs. Mi. 3-26-4 10
Man No 308 | Order No. 39074 | Piece No. 189 | Sub. No.
J. M. Webster | Oper. Code | Mach. Used 235 | No. Pieces 2
Labor | Expense | Overtime | Pattern No. 4660 | Draw No. 1029-K
Piece Name Spur gear.

Assemble	300	Foremanship	343	Relieve	365
Bore	310 ✓	Gear Cut	350	Rig	370
Buff	351	Grind	352	Rough Off	376
Bush	315	Help	354	Saw	371
Chase	320	Key Seat	353	Screw Machine	372
Chip	322	Mill	355	Straighten	374
Cut Off	325	Nut Tap	356	Tap	381
Drill	330	Plane	360	Thread	384
Face	340 ✓	Polish	362	Turn	390 ✓
File	344	Ream	364	Water Joint	393

Weight | Feet | Del. to Dept. B | Finished ✓ | Continued

Fig. 1. Card on which is indicated the Operations to be performed on a Piece of Work in a Given Department

Predetermination of Time

There is only one solution in applying a premium or piece-work system to the shop with non-repetitive work and that is predetermination of time. Where there is but one or a few pieces of a kind and an effort is made to actually time-study them, the pieces are completed before the results can be made use of, and therefore it is necessary to know the time in advance and give it to the workman along with the job.

No doubt many arguments can be raised against this procedure, but just as many can be advanced in favor of it. Questionable means are often justified by results. It will likely be contended that with all the varying conditions to be reckoned with, such as the amount of stock to be removed, the hardness of the material, the condition of the piece or machine, etc., it is an impossibility to accurately compute the time required for a job from a blueprint. If absolute accuracy in time were required, it would be impossible, but this is not necessary. When the computations are within reasonable limits, averages will work out surprisingly close, and that is all that can be desired.

From observations made over a period of more than a decade spent in various shops, the writer maintains that the average workman will reduce machine time approximately 30 per cent when placed on a contract system, as against a straight day rate, provided the incentive is made sufficiently attractive. It has also been observed that on predetermined time work the operator is more likely to over-run the time allowance than to reduce it, because of the unexpected contingencies that are almost certain to creep in. This factor tends to keep the average performance on the safe side.

Now suppose the Halsey premium system is adopted, in which the money saved in reduction of time is divided between the operator and the company, the amount being added to the hourly pay of the operator. Also suppose that the aim is to allow the operator a 25 per cent premium over the day rate when he meets the actual time set. On this basis, granting a 30 per cent reduction in time over day work by the premium plan, the man profits by 25 per cent and the company is 5 per cent ahead on wages and 30 per cent ahead on overhead, as the operator does not figure in this. Should the averages fall a few per cent from the intended 25 per cent for 100 per cent performance, the company is still way ahead on costs over the straight day work plan.

In order to illustrate the practicability of a premium system in a plant manufacturing a line of great variation, the writer will outline in the following the methods used and the results obtained by the company with which he is connected. This company normally employs about 400 men, and the castings on which machine work is done weigh anywhere from a few ounces to 80,000 pounds. The description will begin with the receipt of an order, drawings, and a bill of material by the planning and routing department. Here the casting ticket is issued to the foundry, a duplicate going to the pattern shop as instructions to get ready old patterns or make new ones, as the case may require. The casting ticket designates the order, piece and pattern numbers, quantity of parts, material, and the department to which the foundry is to deliver the casting when made.

Routing Work and Setting Rates

After ordering all castings and other material called for on a bill of material, operation cards are made out by the man in charge of routing the work through the various departments. Fig. 1 shows one of these cards with operations

checked to cover turning, boring, and facing a spur gear. Only such operations are indicated as will be performed on one machine, another card being made out for cutting the teeth, and still another for keyseating the hub. The particular card illustrated is intended for the lathe department. Should there be further machining operations required in some other department, this is designated at the bottom of the card by marking the department to which the part should be delivered. The piece is thus directed on each card until it reaches the erecting floor. A color scheme is used to facilitate grouping cards from various departments.

Night Man No. | Man's Name

Day Started 3-26-24 | Dept. No. 30 | Day Man No. 308

Man's Name J. M. Webster | Order No. 39074

Piece No.	Sub. No.	Oper. Code	Day Prem.	Labor
189			1 4	

Pattern No.	Draw. No.	Man No.	Night Prem.	Labor
4660	1029-K	308		

Pcs. to be Done	Time Hrs.	Set Each Min.	Pcs. Done	Time Allowed	Time Used	Time Saved	Prem. Hrs.	Prem. 10th
2	4	20	2	8 40	5 50	2 50	1	4

Assemble	300		File	344		Relieve	365	
Bore	310	✓	Gear Cut	350		Rough Off	376	
Buff	351		Grind	352		Saw	371	
Bush	315		Key Seat	353		Screw Machine	372	
Chase	320		Mill	355		Straighten	374	
Chip	322		Nut Tap	356		Tap	381	
Cutoff	325		Plane	360		Thread	384	
Drill	330		Polish	362		Turn	390	✓
Face	340	✓	Ream	364		Water Joint	393	

Piece Name Spur gear

Rate Set by F. K. | Night Mach. | Day Mach. 235

Man No.	Day	Start	Stop	Noon	Time Out	OK	Elapsed
	T						
	W						
	Th						
	F						
	S						
	M						

Night Finished | Continued | Total Time Elapsed | % of Total Time

Man. No.	Day	Start	Stop	Noon	Time Out	OK	Elapsed
308	W	9 20	4 10				5 50
	Th						
	F						
	S						
	M						
	T						

Day Finished 3-26-24 | Slip No. 1 | Continued | Total Time Elapsed 5 50 | % of Total Time

Fig. 2. Premium Slip made out for Each Job by the Rate-setter

The man who plans and routes the work as indicated on these cards must necessarily be a thorough mechanic with good judgment. He must be able, after studying each blueprint, to discern the best and proper method of machining the piece. Snap judgment cannot always be used, for in some cases a piece may be machined in two or three different types of machines, but not to equal advantage. After the routing cards on an order or bill of material are completed, they are passed, together with the blueprints, to the rate-setter. To successfully predetermine time from blueprints on all imaginable kinds of machine operations, requires a man who must be good at figures, know machine tools, be an experienced machinist, have good judgment, and be acquainted with every machine in the shop. The rate-setter, upon receiving the operation cards and blueprints, starts at the beginning of the corresponding bill of material and computes the machine time for the steps called for on the accompanying operation cards. This means that on all new work, he analyzes each machine operation and fixes the time allowance to cover it.

For instance, in the case of the spur gear called for on the operation card in Fig. 1, the rate-setter knows from the size of the gear the machine or group of machines on which it should be handled. Experience enables him to estimate within close margins how long it should require for chucking and for setting tools. He also knows the customary allowance for finish on a casting of this nature, and from this can determine the number of cuts required to remove the excess stock. The kind of material, together with the apparent rigidity of the casting and the cutting capacity of the machine, determines the feeds and speeds allowable. There must also be an allowance for changing tools for the turning, facing, and boring steps, and for grinding tools, making measurements, and removing the piece from the machine. After summing up the time and adding the standard allowance for premium, the rate-setter fills in the time and other information shown on the premium slip in Fig. 2, with the exception of the operator's name and number and such other details as must be put in by the foreman when the job is completed. This premium slip is attached to the operation card and delivered to the department that is to handle the job.

Each machine department receives the operation cards and premium slips with the time allowances in advance of the job. When the material arrives in the department and the foreman is ready to begin the work, he withdraws the operation card and premium slip from the pack, and then fills in, on the operation card, the operator's name and number; assigns him the job; gives him the operation card, blueprint, tools, and instructions; and informs him of the time allowed to complete the assignment. The operator rings in his card on starting and rings out on finishing. One advantage is that the operator knows just what he has made on each job when it is completed. The foreman or an assistant also enters on the premium slip the date, operator's name and number, the machine number, the starting and finishing time as shown by the clock registrations on the operation card, and the number of pieces completed. The premium slip is then turned over to the time department for computation.

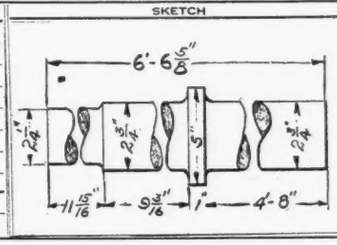
DATE	MACHINE	TOOL STEEL	PRINT NO.	PATTERN NO.	ORDER NO.	PC. NO.	JOB
2-18-24	LATHE	H.S.	1794-M		38922	76	B.S.Co.
DEPT.	NUMBER	MATERIAL					
C	202	F.S.					

DESCRIPTION OF OPERATION

CROSS FEED SCREW CENTERED, FACED AND TURNED COMPLETE FROM ROUGH TURNED FORGING.

OPERATIONS	SPEED	FEED	CUT	TIME
CALCULATED				
TOTAL TIME ON PIECES				
TIME ALLOWED PER PIECE				9:40

SKETCH



REMARKS:

OPERATOR'S PREMIUM ON 2 PCS. 21%
ACTUAL TIME 6.8 HRS.

Fig. 3. Form on which Information concerning Jobs can be recorded for Future Reference

The operator, upon receiving a job and the time allowance, can do little more than guess at the fairness of the time, but he knows that the rate-setter computed the time and that if he exceeds the time allowance or reduces it, he will be paid accordingly; therefore it behooves him to do his best. It is not an uncommon occurrence when a man fails to meet the time set on a job to demand that it be rechecked, not so much for the reason that he wants more premium as to vindicate himself from loafing on the job. Unusual conditions and circumstances arise occasionally, such as exceptionally hard material or excessive stock. In such cases the man notifies the foreman who, in turn, takes the matter up with the rate-setter, and has the time adjusted if the complaint is justified.

Records for the Guidance of the Rate-setter

Predetermining the time allowances from blueprints requires exacting calculations,

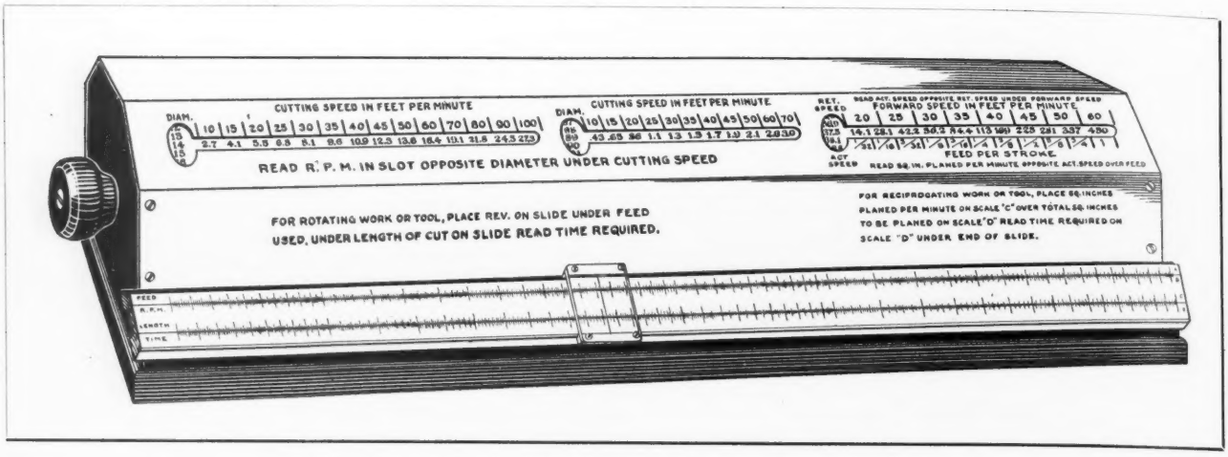

DIAM.
CUTTING SPEED IN FEET PER MINUTE
10 15 20 25 30 35 40 45 50 60 70 80 90 100
2.7 4.1 5.5 6.8 8.1 9.6 10.9 12.3 13.6 16.4 19.1 21.8 24.5 27.3
READ R. P. M. IN SLOT OPPOSITE DIAMETER UNDER CUTTING SPEED
FOR ROTATING WORK OR TOOL, PLACE REV. ON SLIDE UNDER FEED USED, UNDER LENGTH OF CUT ON SLIDE READ TIME REQUIRED.
FORWARD SPEED IN FEET PER MINUTE
20 25 30 35 40 45 50 60
14.1 22.1 42.2 56.2 74.4 113 160 225 281 337 450
FEED PER STROKE
FOR RECIPROCATING WORK OR TOOL, PLACE SQ. INCHES PLANED PER MINUTE ON SCALE "C" OVER TOTAL SQ. INCHES TO BE PLANED ON SCALE "D" READ TIME REQUIRED ON SCALE "D" UNDER END OF SLIDE.
FEED
R.P.M.
LENGTH
TIME

Fig. 4. Calculator for quickly determining the Machine Time of Operations

and the rate-setter should have ready access to tabulated records of past performances for comparison on similar work. From such records he can check figures or take the time direct on duplicate work. It is a good plan to record performance on standard or principal parts for reference, and Fig. 3 shows a simple and useful form that is used for this purpose.

Sketches for use on this slip can be made up by apprentice boys drafted from the shop for reasonable periods of time. The descriptive matter and other data is typewritten on the form. The space for information, covering feeds, speeds, cuts, etc., is not intended for predetermined calculations, but is made use of where actual performance is occasionally timed on pieces that are of special importance or are being put through in quantity lots. These records gathered over a considerable period of time and properly indexed are a valuable asset to the rate-setter. The actual percentage of premium previously made is entered on the record in each case, and he can be guided somewhat by these past results.

After the premium system had been established, it was found that the pencil calculations necessary in computing scores of new machine operations daily, consumed too much time, so it was found necessary to devise some means to expedite this work. With a little thought, the calculator shown in Fig. 4 was made up, and it has proved very useful. It can be used for computing operation time on practically any machine in the shop, whether the tool or the work rotates or reciprocates. A description of this calculator and the method of using it was published in March, 1922, MACHINERY.

The premium slips are made up and turned in to the time and cost department in duplicate, where the time and premium is computed, after which one copy is returned to the rate-setter so that he may note high or low earnings or any irregularities that may appear. He selects such operations as may be valuable for future reference, and has them made up on the permanent record form shown in Fig. 3. All returned premium slips are finally filed together according to the order number, so that in case a duplicate job is put through the shop at some later date, the entire lot can be conveniently taken from the files and used in making up the premium time.

The cost department furnishes a premium statement, such as shown in Fig. 5, to the superintendent and his assistant, on which is tabulated all work on which less than 5 or more than 30 per cent premium was earned. From this can quickly be seen the earnings that are out of line. It also gives the superintendent an indication of incompetent men who rarely or never earn a premium, as well as exceptional men who constantly earn a high percentage. A further analysis sheet is furnished weekly to executives, which shows the premium situation by departments. An analysis for the year 1923 shows that of the total premium time possible in all machine departments, 82 per cent was on this predetermined basis, and the average premium earned over the day rate was 17 per cent. Going to make up this average of 17 per cent, there were, of course, many instances where the operators consumed more time than allowed, and numerous cases where the earnings were excessive. These cases must necessarily occur among the great number of men involved, for the premium rates are not set to suit the capabilities of the individual. However, from the perspective of the year's performance, the results demonstrate that premium time can be predetermined successfully.

* * *

The National Vigilance Committee of the Associated Advertising Clubs of the World, 110 W. 40th St., New York City, has called attention to the fact that a gentleman in Chicago, who claims to be an experienced employer of draftsmen for a large and well-known engineering firm, offers to train personally, by correspondence, young men for the work of the draftsman and designer. It is stated that the advertisements of this instructor claim that anyone studying his course for the equivalent of about six weeks a solid eight hours a day, is then prepared to earn, and in fact is guaranteed, a salary of from $250 to $300 a month. Anyone familiar with the work of draftsmen and designers knows that only men of exceptional experience and ability earn that amount a month. Such advertising is exceedingly misleading, and young men expecting exceptional results are disillusioned because of the exaggerated promises made. The Federal Trade Commission is investigating this matter and may place a restraint on such extravagant advertising.

PREMIUM STATEMENT

Week Ending March 25, 1924 Sheet No. 1.

% Prem. Apportion	Dept.	Man No.	MAN'S NAME	Order No.	Piece No.	Sub. P No.	OPERATION	PIECE NAME	Time Set By	Mach. Used	No. Pieces	Time Each Hrs.	Time Each Min.	Time Set Hrs.	Time Set 10th	Time Used Hrs.	Time Used 10th	Time Saved Hrs.	Time Saved 10th	Premium Hrs.	Premium 10th	Hourly Rate	Premium Earned	Actual Hr. Rate	Ratio Prem to Hr. Rate
	A	466	W. L. Freeman	38911	46		Bore face	Bearing	J.P.	306	3	3	10	9	5	8	8	—	7	—	4	0.65	026	0.68	4%
	C	204	B. M. King	38870	137		Turn & chase	Valve stem	" "	77	1	8	0	8	0	4	5	3	5	1	8	0.66	1.19	0.92	39%

Fig. 5. Premium Statement on which is listed all Work on which the Premium earned was Less than 5 Per Cent or More than 30 Per Cent

Universal Gear Testing Machine

By F. JOHNSTONE-TAYLOR

NUMEROUS machines and methods for testing gears have been developed in the past, but most of these have had only a limited application. Consequently, a testing machine that is universal in that it may be used for any kind of gear and for recording errors in the running of meshed gears, will be of especial interest. Such a machine has recently been developed by the National Physical Laboratory of Great Britain under the direction of G. A. Tomlinson. Fig. 1 shows a general view of the machine with certain parts removed for the sake of clearness.

The gear being tested is mounted on an arbor held between the centers of the machine, as shown in Fig. 2, and a steel ball is brought into contact with the gear teeth. This ball forms the end of a stylus attached to a pencil indicator that is contained within housing *A*. This unit of the machine is shown diagrammatically in Fig. 3, from which it may be seen that the unit is provided with a taper shank *B* which fits into the upper carriage of the machine. The stylus *C* really comprises the short arm of lever *D*, whose long arm carries a curved knife-edge *E* for conveying to micrometer *F* the small vertical changes in the position of the stylus ball. Lever *D* is suspended on light crossed steel strips at *G*. The position of edge *E* relative to the micrometer spindle is observed through an adjustable glass prism *H*, Fig. 2.

MAJOR F. JOHNSTONE-TAYLOR, the author of this article, is a graduate of the Engineering School of Dublin University. After having acquired experience in the shops and drafting-room of the Great Southern Railroad of Ireland, he entered the Public Works Department of the government. At the outbreak of the war, Major Johnstone-Taylor, then a captain in the territorial army, went to France, and after having been severely wounded, he superintended the design and equipment of several of the national factories for the production of war materials. He was sent to the United States to study American methods of intensive production, and was largely instrumental in organizing quantity production in the munitions factories. Since the termination of the war he has been engaged in consulting engineering practice, largely in connection with the solution of manufacturing problems and power developments.

Plate *G* (Fig. 3) from which lever *D* is suspended may be moved vertically one inch on steel ball races, any movement being measured by means of micrometer *J* which has a spherical-end spindle bearing on a hardened and lapped face of plate *G*. The weighted crank-lever *K* and the pointed strut pin *L* hold plate *G* against the ball race and also against the spindle of micrometer *J*. The whole indicator swivels on stem *B* to permit the testing of bevel gear teeth.

It will be observed from Fig. 1 that the machine is provided with two carriages, an upper and a lower one. In measuring the circular pitch of a gear, the lower carriage is advanced until the ball of the stylus is brought to bear either upward or downward on a tooth, preferably at the pitch line. A reading is then taken with the spindle of micrometer *F* just touching edge *E*, Fig. 3. The carriage and stylus are then withdrawn and the gear rotated through an angle equal to the nominal angular pitch after which the stylus is again advanced and another reading taken. The error in the circular pitch is one-fifth the difference between the two readings, as the ratio of the lever is 5 to 1. This process may be repeated all around the gear.

Disk *M*, Figs. 1 and 2, is a bronze wheel rigidly secured to the projecting end of a spindle that is coupled to the gear. The boss of the disk forms a bearing on which a long steel bar which serves as a sine plate may be mounted, as illustrated in Fig. 5. This sine plate can be rotated relative to the disk or locked to it by means of the locking arrangement shown at *N*, Fig. 6. There is also a clamp between the disk and the frame at *Q*. At *O* is a ¾-inch steel ball which rests on a Johansson gage-block *P* to give the horizontal zero of measurement. If another Johansson gage-block is added and the disk rotated through angle a, the height of the gage-block will be equal to $x \sin a$, the value of x being 10 inches.

To obtain a circular pitch measurement on a spur gear by this method, the sine plate is set to zero, the indicator advanced so that the stylus ball bears on the tooth flank, and the gear rotated successively through the nominal angular pitch by using the sine plate. Each time a tooth is brought to the stylus a reading is taken with micrometer *F*, Figs. 1 and 2. As before, the difference in the readings represents five times the actual variations in the circular pitch. By making a chart of the readings, the periodical errors in the teeth of the gear may be more readily studied.

In checking the parallelism of the teeth with the gear axis, the stylus of the indicator is placed in contact at one end of a tooth flank and a reading is taken. The indicator is then traversed along the tooth by turning a micrometer screw. A series of readings taken at various points by means of micrometer *F* will give the error in parallelism.

While it is possible to measure the tooth form and thickness by a point-to-point method, the process is laborious. For these steps the machine employs the

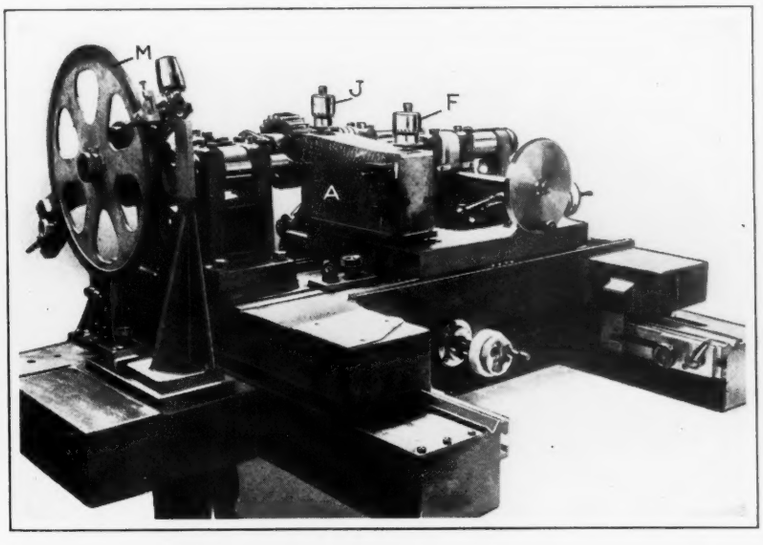


Fig. 1. Machine that may be used for determining the Accuracy of All Types of Gears

pantograph shown in place in Fig. 7 and diagrammatically in Fig. 4. With this pantograph, the profile of a tooth can be traced from both flanks, the gear reversed on the centers of the machine, and the same tooth traced again from the opposite side of the gear. The two traced flanks should coincide, but if they diverge, the angle of inclination measured on the projection is double the actual error of the tooth.

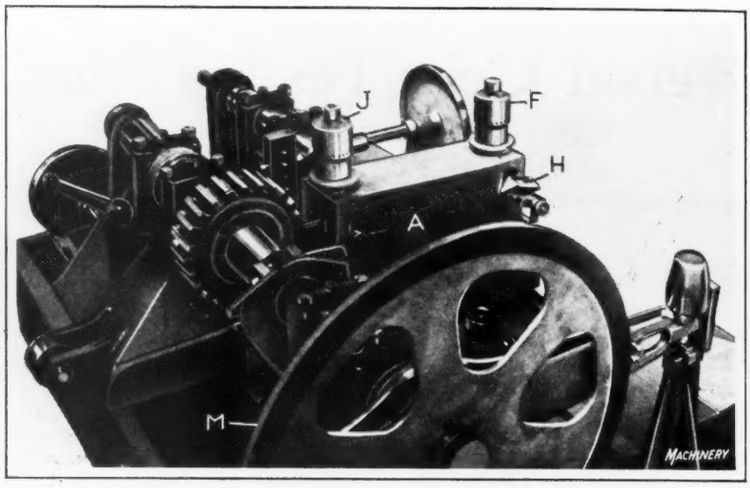


Fig. 2. Manner of supporting the Gear to be tested between Centers

tooth record has been taken, the gear is replaced by a cylinder of known diameter and a portion of the cylinder circumference is traced on the same record in such a way that the arc of this circle intersects the tooth flank previously traced. The base-circle diameter can then be graphically derived by a simple construction on the board of the projector, the construction being based on the properties of the involute.

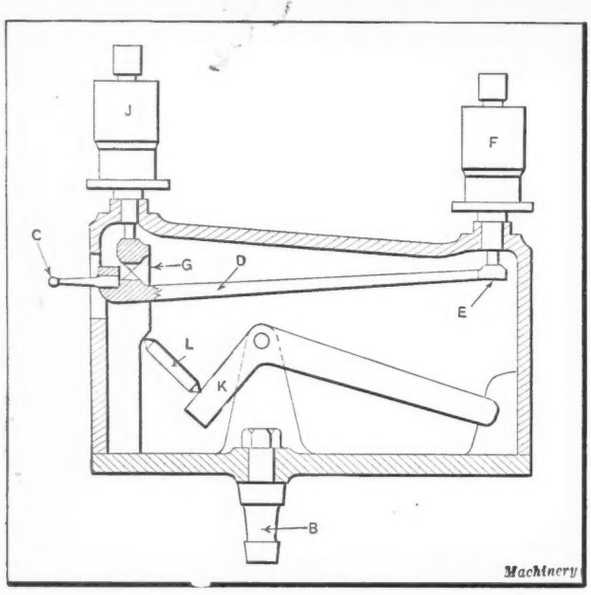


Fig. 3. Indicator used to obtain Micrometer Readings of Inaccuracies of Gear Teeth

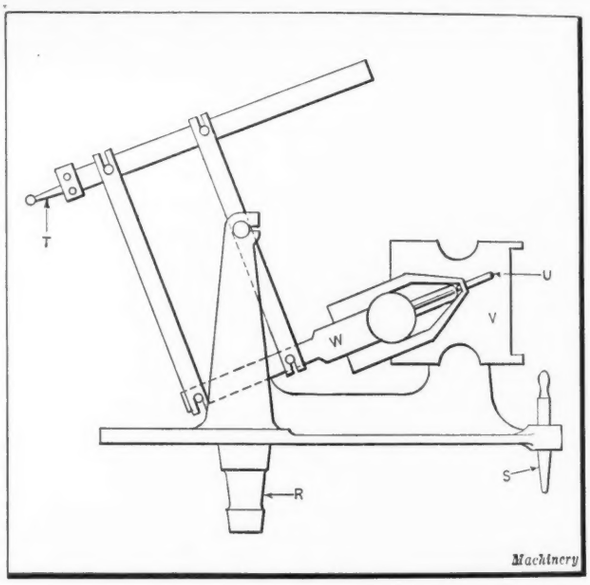


Fig. 4. Pantograph for tracing Contour of Gear Teeth to a Larger Scale

From Fig. 4 it will be seen that the pantograph is also fitted to the machine by means of a taper shank *R*, pin *S* serving to locate the device normal to the axis of the gear. The tracing point *T* is a spherical-ended stylus which is clamped in vees of the upper link of a parallelogram. The marker *U* is a fine steel point which bears on a smoked glass plate *V*. The holder of part *U* is adjustable relative to the lower link *W* of the parallelogram. The pantograph is balanced about its fixed axis so as to establish an equilibrium for all shapes and positions.

The pitch diameter can also be accurately determined by the aid of this pantograph. After a

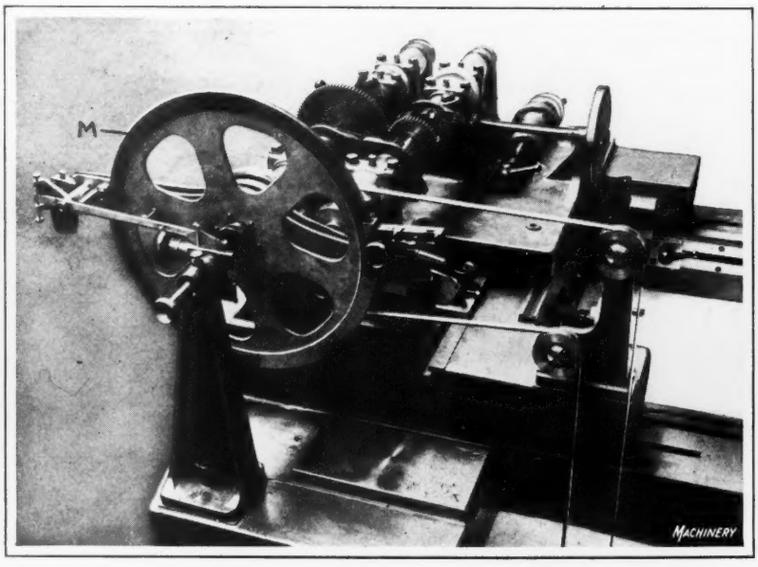


Fig. 5. View of the Machine with the Sine Plate in Place

For the most part, helical gears are dealt with in the same manner as spur gears. In addition to tests of the kind described, the indicator is used for testing the helical pitch and the pitch angle. It is set in contact with one end of a tooth flank and moved along the tooth by traversing the upper carriage in equal steps, the gear being meanwhile rotated in stages, by means of the sine plate, through the appropriate angle determined by the helical pitch. Readings of the indicator give the deviations of the specimen from the nominal true helix.

The pitch measurement of a bevel gear is also carried out as just explained, except that the indicator is swiveled

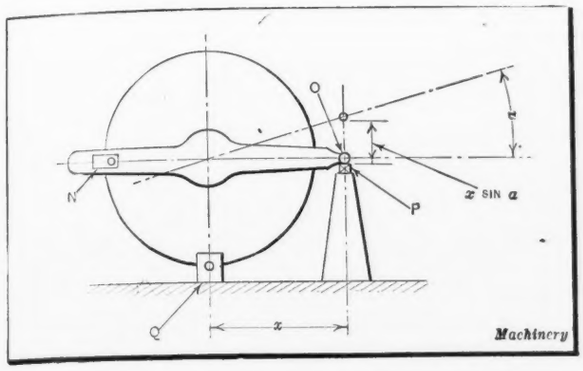


Fig. 6. Diagram illustrating the Use of the Sine Plate

around on pin *R*, Fig. 4, so that the plane becomes normal to the pitch cone. The procedure is practically the same for spiral bevel gears, while worm-wheel measurements taken in the central plane of the wheel are made the same as in the case of helical gears.

* * *

ACCIDENT PREVENTION SYSTEM

By K. C. MONROE

Records kept over a considerable period of time indicate that the majority of accidents in the plants of the Bridgeport Brass Co., Bridgeport, Conn., are the direct result of carelessness on the part of the workmen. To keep this fact constantly before the employes, special efforts are made by a safety and sanitation committee, which also formulates plans for improving conditions. This committee consists of twelve members and a secretary, six members being elected annually by the employes and the other six being appointed by the management. The management, too, appoints the secretary, who also serves as the safety engineer of the company. An equal number of the committee members is chosen from each of the two plants.

The safety and sanitation committee meets once every month, alternately at each plant, with a chairman presiding who has been elected by the members themselves. At these meetings all questions pertaining to safety and sanitation are discussed, and the secretary reads a report covering all lost-time accidents that occurred since the previous meeting. Conditions that contributed to the cause of each accident are analyzed in order to determine what style of safety device could prevent a repetition of the accident, or if the accident is found to be due to carelessness on the part of the injured employe, what instructions should be issued to other employes doing similar work.

The secretary also describes any action that he may have taken as safety engineer in the removal of hazardous conditions since the previous meeting. All safety suggestions are discussed after the report has been finished, and any recommendations that may have been made are voted on. Each member of the committee is then given an opportunity to suggest improvements in safety and sanitation.

Once each month an inspection of the plants is made by the committee. In order to make these inspections more interesting, a novel idea has been adopted. This consists of the members from one plant inspecting the other plant on alternate months. The plan has created a spirit of friendly rivalry between the two plants that has resulted in the discovery of hazards that might otherwise have been overlooked. Many improvements that have been made can be attributed directly to the diligence of the committee on these inspections. In addition to the guarding of machinery, particular consideration is given in these inspections to poor lighting, obstructed passageways, unguarded floor openings, and any other conditions that might cause an accident. Special attention is also given to sanitation, dust and acid-fume conditions are investigated, and the general appearance of departments is noted.

FOREMAN'S REPORT OF ACCIDENT

Name..... No.....
Department.....
Date of accident.....at.....A. M. / P. M.
Date reported.....at.....A. M. / P. M.
Give in brief, description of accident and cause.....
.....
.....
If serious,
Name witnesses 1. ..... 2. .....
Was there any evidence of misconduct, or defective machinery?.....
.....
What safety appliance would have prevented accident?
.....
.....
Foreman, Bridgeport Brass Co.

Form on which Information concerning Each Accident is sent to the Safety Engineer

The safety engineer accompanies the committee on these inspections, and prepares a report covering all recommendations. This report is then taken up with the management, and orders are placed to carry out all the recommendations that are approved. It is also the duty of the safety engineer to make a personal investigation of all the accidents of a serious nature. Each foreman is required to report every lost-time accident in his department on the form illustrated. This report is forwarded to the safety engineer, but in case of a serious accident the foremen are expected to advise the safety engineer by telephone in order that an investigation can be made without unnecessary delay.

To encourage safety suggestions from employes, an award of $5 is paid for each suggestion adopted by the committee. From ideas obtained in this way, a number of good machine guards have been developed. Safety notices are posted on bulletin boards, which are placed in conspicuous places in all departments, and records showing the time lost by departments as the result of accidents are kept. These data are used to stimulate rivalry between departments in maintaining a good record. Charts that show the cost of accidents per $100 payroll are also posted.

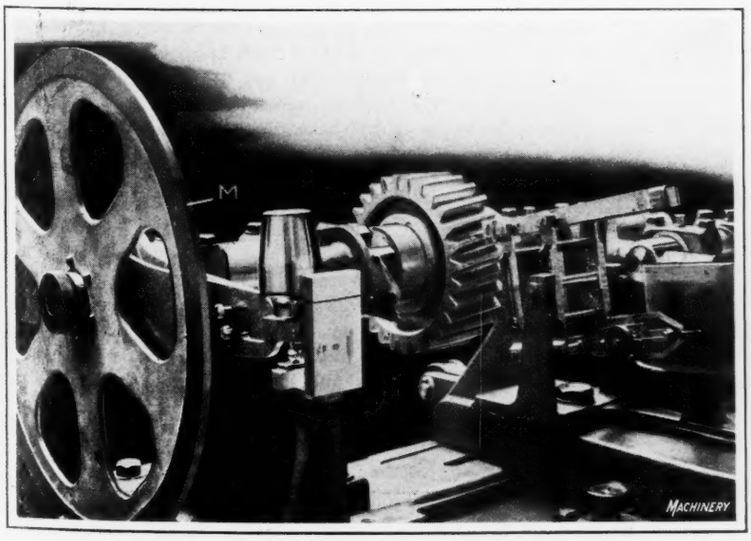


Fig. 7. Using the Pantograph for determining the Accuracy of a Helical Gear

Temporary Jigs and Fixtures

By S. W. BROWN

At one time the writer was employed by a shoe machinery company which had a large fireproof vault for storing jigs and fixtures. In a compartment of this vault was stored one of the finest sets of jigs and fixtures that the writer has ever seen. It was said that the cost of this special equipment was $25,000. Shortly before the company discontinued business, the expensive set of jigs and fixtures was removed from the vault, broken to pieces, and sold for scrap. The reason for disposing of the tools in this manner was that they had become worthless, having been built for use in the manufacture of a special sewing machine that had not proved a success.

The expensive set of jigs and fixtures had been made as soon as the sewing machine appeared to have passed the experimental stage but had not been well established upon the market. The first machine gave such promising results, however, that everyone concerned believed the making of the special tools a perfectly safe proposition, but unfortunately the machine proved to be a failure after a thorough trial by several shoe manufacturers. The company that sustained this loss is not the only one that has found it necessary to scrap an expensive set of fixtures because the product for which it was made proved impractical.

The manufacture of interchangeable parts for a lot of machines on an economical basis naturally requires the use of jigs and fixtures, but in most cases where small lots of experimental machines are to be made, it is generally the best practice to make a set of inexpensive, temporary jigs and fixtures. In cases where only a few machines are to be built for use in the manufacture of the products of a single company, special tools, if made at all, should be of the inexpensive, temporary type. In any case it is unwise to make an elaborate and expensive set of jigs and fixtures for a machine that is not perfected and established on the market, and until it is, the safest course is to build the machines

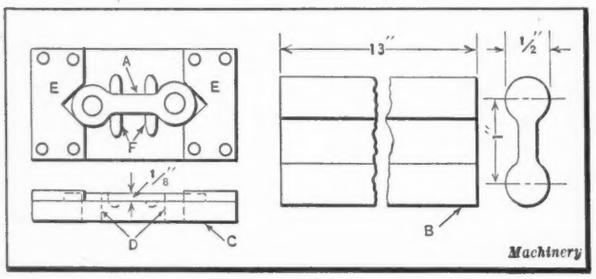


Fig. 1. Method of making Small Links

with the regular stock equipment, or at least with the aid of only the most inexpensive types of jigs and fixtures.

Before starting to build a small lot of machines, an estimate should be made to determine whether or not the cost of making special tools plus the cost of manufacturing the parts by the use of the special tools exceeds the cost of manufacturing the parts with standard equipment. The quality of the work produced and the probability of obtaining additional orders are factors that should be considered. Success in building machines in small lots depends largely upon the ingenuity and resourcefulness of the mechanic who plans and superintends the work.

Points to Consider in Building Machines in Small Lots

As an example let it be assumed that a lot of ten machines is to be built. Generally speaking, this number of machines is not large enough to warrant the making of expensive jigs and fixtures, but is large enough to justify the making of simple fixtures for some of the parts. Thus it becomes a problem to determine which parts can be produced to the best advantage by the use of temporary jigs or fixtures. While the size of the machine is not very important, it may be well to assume, in this case, that it is, roughly, 4 feet long, 2 feet wide, and about 4 feet high. Let it be assumed also that the machine is constructed with a base member mounted on machine legs and that most of the mechanism is mounted on the base member, the mechanism consisting of parts that are common to the average machine,

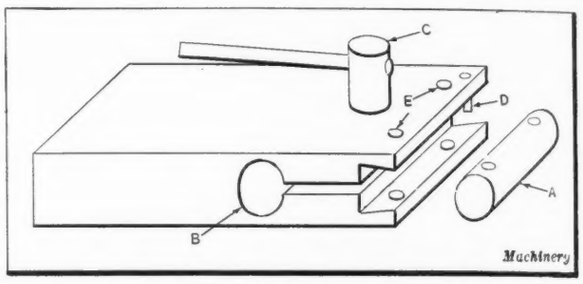


Fig. 2. Drill Jig of Simple Construction

such as bearings, brackets, shafts, levers, links, and similar parts.

The problem is to machine the parts and assemble the lot of ten machines as well and as economically as possible. In the case of the legs that support the machine base, no special machine tools are required, the surfaces that are fitted to the base being machined on standard tools.

Simple Templets for Locating Drill Holes

The base of the machine can be machined with standard equipment, except that a templet should be used for locating the drilled holes. The templet may be made from 3/16- or 1/4-inch sheet steel, cut to the same shape as the top of the machine base but enough larger to permit two locating pins to be placed at one side and a third pin at an adjacent side. The templet is properly located when these pins are in contact with the sides of the base, and may be held in place by stock clamps. The holes that guide the drills are laid out and drilled in the templet in the usual manner.

In some cases templets made from sheet metal having a thickness of only 0.020 inch may be as satisfactory as those made of thicker stock, and they will certainly be less expensive. The position of the drilled holes is laid out on the thin metal in the regular way and a 1/16-inch hole drilled at the center of each hole laid out. After the templet is clamped to the machine base, the locations of the various holes are transferred to the work by means of a punch inserted through the 1/16-inch holes.

Templets of the type described may be used to advantage in locating the bolt holes in brackets, bearings, and stands that are to be mounted on the base. As such parts are required to match corresponding holes in the base, they are generally drilled out 1/32 inch larger than the bolts or screws with which they are to be attached to the machine base. When the parts have been bolted to the base and properly aligned, they should be doweled so that they can be disassembled and assembled as many times as necessary without changing their location.

Method of Producing Cams

As cams perform important functions in nearly every machine, we will assume that several cams are required. Almost every machine shop is equipped with some kind of

cam-cutting machine or milling machine attachment, so that it is only necessary to make up templets or master cams for use with the cam turning tools. The special cam templets or master cams may be made of 3/16-inch sheet steel if the cams are of the side-groove type, but if peripheral cams are required, it may be necessary to make up special castings to guide the cam forming tool.

Jigs and Fixtures for Small Parts

There are various small parts on a machine of the type considered which would ordinarily be made on a punch press if required in large quantities. A part of this kind is shown at *A*, Fig. 1. In this case sixty of these pieces are required for ten machines, and it would hardly pay to make a punch and die for such a small quantity. On the other hand, it is a tedious and costly job to produce these parts from ⅛-inch cold-rolled steel. A less expensive and a convenient method of making these parts is to select a piece of machine steel ⅝ by 1⅝ by 13 inches in size, and machine it to the shape indicated at *B*, Fig. 1. The part can then be sawed into pieces ⅛ inch thick plus a grinding allowance of 0.010 inch. After grinding both sides of these pieces on a surface grinder, the holes are drilled by the use of the inexpensive jig shown at the left-hand side of Fig. 1. The plate *C* of this jig contains the holes *D*, which guide the drills. The locating V-blocks *E* are riveted to plate *C*. Two slots *F* are milled to a depth of 1/8 inch with a 3/16-inch round-faced cutter to provide clearance for the end of a screwdriver, or whatever tool is used to pry the drilled pieces from the jig.

In Fig. 2 is shown a simple drill jig for use in drilling the cross-holes in the pin shown at *A*. This jig is made from a piece of cold-rolled steel, ¾ by 1½ by 3 inches in size. A sufficient amount of spring is given the clamping jaws by the hole *B* to permit the jaws to be tightened on the work by a slight turn of the screw *C*. The work is located endwise in the jig by means of the pin *D*. The holes *E*, which guide the drill, are not bushed, as the jig is to be used for the production of only 120 pieces.

It seldom pays to make milling fixtures for parts required in small lots, but in many cases special vise jaws made of cold-rolled steel can be used to advantage. These vise jaws can be drilled and tapped so that they can be secured to the vise in place of the regular jaws. The work can be located on the fixed jaw, either by means of pins or by recesses milled on the jaw. The principles embodied in the simple jigs and fixtures described have been applied with great success in solving many troublesome production problems, and they can doubtless be employed advantageously by others who encounter similar problems.

HOBBING IN THE LATHE

By FRANK H. MAYOH

Although the lathe is especially designed for turning with a tool held stationary in the toolpost while the work revolves with the spindle, there are occasions when the process is reversed, the tool, in the form of a hob, being secured to the spindle and revolved to machine work fastened to the cross-slide of the lathe. Examples of this process are shown in the accompanying illustrations. In Fig. 1 is shown a half-nut *A* in which a thread is cut by the hob *H* held between the two centers *B* and *C* of the lathe. This hob has spiral grooves, and is revolved between centers by dog *J*.

The work *A* is held to a block *D* mounted on the cross-slide *E* of the lathe. Screw *F* is used to clamp block *D* in the position originally occupied by the toolpost. The work is clamped in position by the screw *G*, and is held square or parallel with the lathe spindle by the tongue and groove construction shown at *K*. The lathe is geared up so that the carriage is fed along at the correct speed for the lead of the thread being hobbed. The carriage is traversed back and forth longitudinally by the threading screw the same as when cutting threads with a single-pointed threading tool.

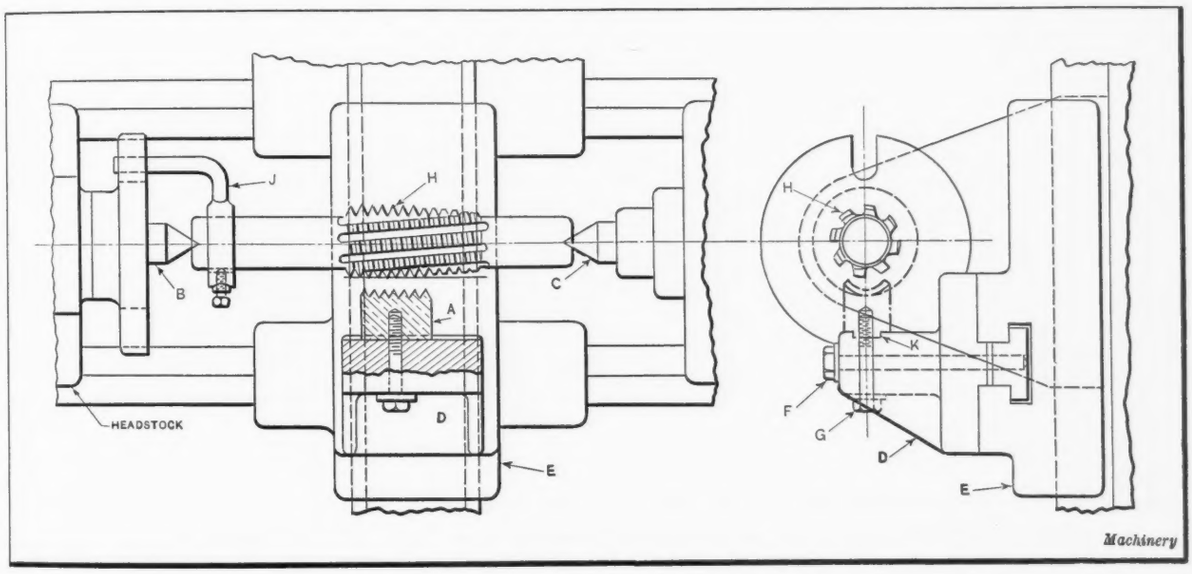


Fig. 1. Set-up for hobbing the Thread in a Half-nut

While the carriage is traversed in a forward direction the cross-slide is fed in so that the work *A* will just touch the top of the hob threads. The first cut is then made by allowing the work to travel past the hob on a line parallel with the axis of the hob. After taking this cut, the cross-slide is withdrawn so that the work will not be in contact with the hob while the lathe is reversed, or run backward, the same as in threading. The cross-slide is next fed in a few thousandths inch deeper, and another cut taken in a similar manner. This process is repeated until the thread is cut to the required depth in the half-nut *A*. The indicating dial on the lathe cross-slide feed-screw may be used for governing the depth of each cut. If the cross-slide is not backed up after each cut, when the lathe is reversed the backlash will cause the hob to drag in the threaded nut on the reverse traversing movement.

FRANK H. MAYOH, the author of the accompanying article, received his engineering education at the Rhode Island School of Design. He learned the toolmaker's trade with the J. M. Carpenter Tap & Die Co., and the draftman's trade with the Potter & Johnston Machine Co., Pawtucket, R. I. Since that time he has held positions as designer of small tools and machine tools, chief draftsman, assistant to the manager of manufacturing concerns, and has also been engaged in sales service engineering. His specialty is the development of new designs and tool engineering for production, and he has been employed by the Taft-Peirce Mfg. Co., J. T. Slocomb Co., Oswego Machine Works, New Departure Mfg. Co., Eastman Kodak Co., and the National Blank Book Co., where he is now engaged on mechanical development work. Mr. Mayoh is an associate member of the American Society of Mechanical Engineers. He is 34 years old and lives at 72 Westfield Road, Holyoke, Mass.

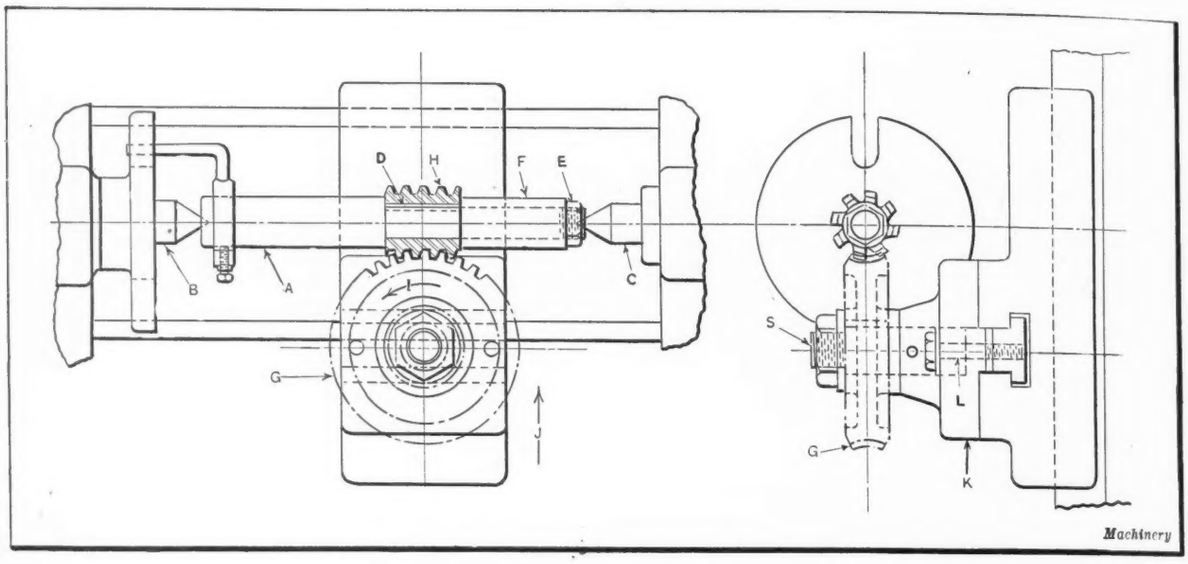


Fig. 2. Method of hobbing the Teeth in a Worm-wheel

A method similar to the one just described is employed to hob worm-gears in the lathe, except that the cross-slide of the machine is held stationary and does not travel longitudinally as in the case just described. The hob itself must be the same diameter as the worm which is run with the worm-gear (see Fig. 2). In this illustration, *A* indicates an arbor held between centers *B* and *C*. The hob *H* is held on the arbor and is driven by a key at *D*, while a nut *E*, in combination with the bushing *F*, holds the hob in place on the arbor. The hob is of the worm thread type, and the worm-gear *G* is free to revolve on the stud *S*. When the worm-wheel is fed against the hob, the hob will cause it to revolve. In taking a cut with a right-hand hob, the worm-gear will be revolved in the direction indicated by the arrow *I*, and as it revolves the cross-slide of the lathe is fed inward in the direction of the arrow *J* until the worm-gear teeth are cut to the required depth.

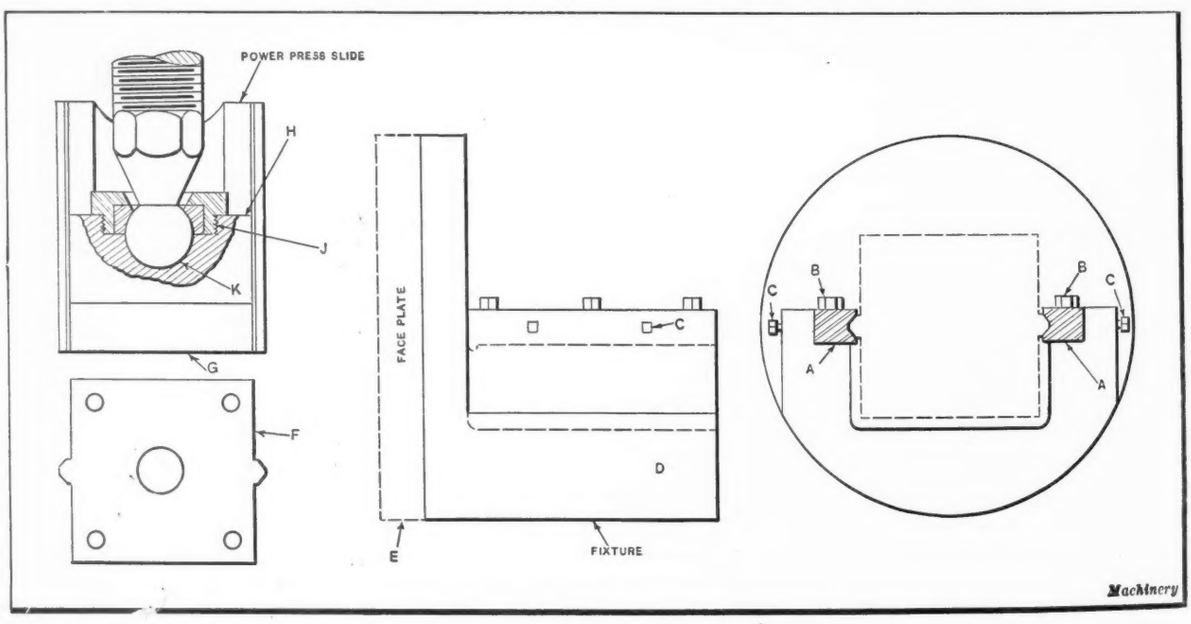
The block *K* is held to the cross-slide of the lathe by screw *L*. The plug or stud *S*, in combination with a nut and washer, is employed as a means of holding the worm-wheel *G* on the block *K* in such a manner that it will be revolved by the hob. While the methods of hobbing described are not in general use, they nevertheless permit a good rate of production to be maintained.

MACHINING POWER PRESS SLIDES

By FLOYD GRAVES

A fixture which was designed by the writer for use in machining power press slides and has proved very satisfactory is shown in the two views at the right-hand side of the accompanying illustration. The V-blocks *A* which locate and hold the work to be machined are made in different sizes to accommodate slides of various sizes. The V-blocks are held in place by screws *B* and adjusted by means of the set-screws *C*. The base *D* of the fixture is doweled and bolted to the faceplate *E* which, in turn, is secured to the lathe chuck. After the slide *F* has been clamped in place between the V-blocks *A*, surface *G* is faced off. When this has been done, the slide is reversed in the fixture, the surface *H* faced off, the hole bored at *J*, the ball seat *K* machined, and the hole *J* threaded at one setting.

Originally several settings of the work were required to complete the machining operations—a procedure that made it very difficult to obtain an accurate or satisfactory slide. After the fixture shown in the illustration was put in use, however, no difficulty was experienced in obtaining the required accuracy, and, in addition, the production time was greatly reduced.



Power Press Slide and Fixture in which it is machined

Feeding Devices for Automatic Machinery

By ALBERT A. DOWD

WHEN an automatic machine designer has solved a great many problems during the course of his experience, he reaches a point at last where he does not need to do so much experimenting before he hits upon a good method for a certain operation. The series of experiments described in the last article was given largely to help the designer whose experience has been comparatively small, and to show him, by means of actual examples, the difficulties encountered in the work in order to get him started along the right track. It is not the intention to treat every problem in this way, nor must it be thought that the methods suggested are the only ones that will produce good results. Two experienced men working on the same problem will seldom decide upon the same method of handling, yet both solutions may be equally good. When experimenting with a model, if it is found that it works properly without a slip or failure under every test, it may be considered satisfactory, but when it fails to function *just once*, the trouble must either be overcome or a different scheme tried.

Preliminary Considerations

Two jobs may be similar but they are not often exactly alike. A machine may have been designed and built for a certain operation, and the designer may be called upon to design another for a piece of almost the same shape. A small difference may make it necessary to use an entirely different method of handling. It is best to develop an idea along lines that previously have been found successful, whenever this is possible, but for much of this work there is no precedent, and a new idea must be worked out to suit the case. Take nothing for granted, until it has been proved.

A customer may say, "I want to dump all these three sizes of pieces into a hopper and have them come out through three chutes separated according to their size. Can you do it?" Assuming that the designer is confronted with a case of this kind (which is by no means uncommon) it may be best to answer the question by asking another, for example: "Why don't you separate them first as they come from the manufacturing machines, and keep them separate?" There may be conditions which prevent this, but usually much can be done to simplify a design by adopting improved methods for previous operations. Many people think that one can do anything with an automatic machine, and while there is some truth in this, the cost may be prohibitive. One complicated machine can sometimes be designed for several operations on a difficult piece of work, but it is always expensive and likely to get out of order. It is nearly always better to use two or three simple machines than to make one complicated one, for in the latter case, when anything goes wrong with the machine the entire production stops until the trouble is overcome. The careful designer considers these points before he starts actual work.

A designer is frequently called upon to handle and arrange pieces that are dumped into a hopper in a jumble, and many times a much simpler arrangement could be used by starting at the beginning of the problem instead of in the middle. Any piece of work that is made in a machine is removed from it in a uniform manner, and if, after completion, these pieces are to be packed in a carton, package, or box, the feeding into the packing machine can be greatly simplified by devising a simple arrangement to apply to the machine that does the manufacturing. Such a device can often be made to stack the pieces into a removable carrier or magazine which can then be attached directly to the packing machine. The nature of the work sometimes prohibits the use of anything of this sort, but it is well to keep it in mind as a possibility.

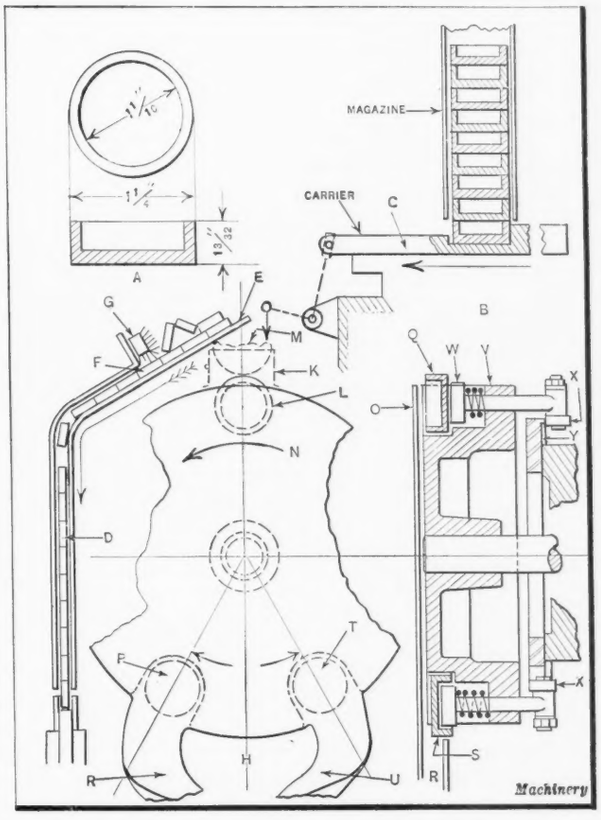


Fig. 1. Feeding Device for Cup-shaped Wooden Disk shown at A

In the selection of pieces from a mass, there are several principles frequently used: Gravity, vibration, oscillation, rotation, and centrifugal force. Some kinds of pieces will fall by gravity, perhaps assisted by vibration of inclined planes or hoppers. Others need to be oscillated in order to disturb the mass and change the arrangement continually. The principle of rotation is often applied in many ways, some of which have been illustrated in previous articles. Centrifugal force can be applied successfully to separating devices, but its application in automatic machine design is seldom appreciated by the average designer. Gravity and vibration are probably most used, yet both of these methods must be applied properly to secure positive results. If we should place a single piece of work of a given shape in a fixed position on an inclined plane, we know that it will slide downward if the angle is great enough, but if other pieces are in contact with it, we cannot tell what may happen. Several examples will be shown in this article to indicate the advantages of prearrangement of pieces before handling.

Examples of Different Designs of Feeding Devices

At *A* in Fig. 1 is shown a cup-shaped wooden disk which is to be passed through a machine and the depression filled with a composition. Our problem calls for feeding the pieces in such a way that they will always come through the machine cup side up. If they are arranged in a stack as at *B*, the matter is quite simple, as they will drop easily into the carrier *C* ready for any other operation.

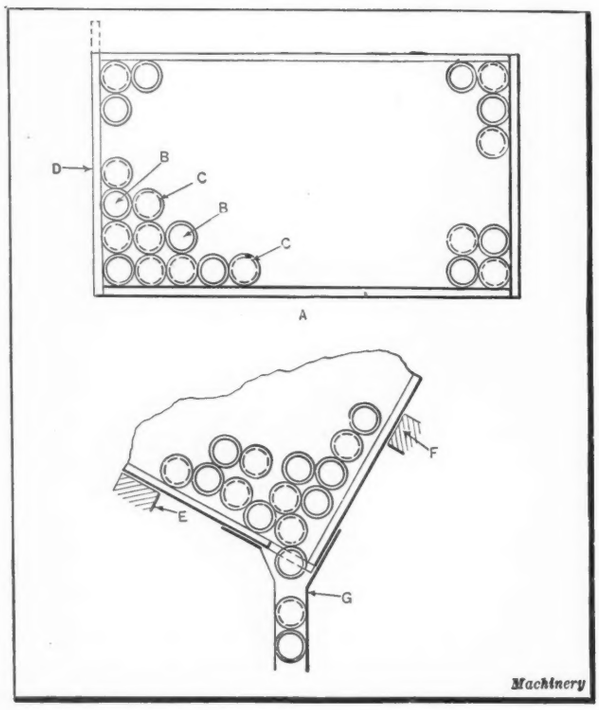


Fig. 2. Inclined Tray Method of feeding Pieces into a Chute

If we are required to handle the pieces from a hopper, the first step is to flatten them out so that they will slide edgewise down a chute, as indicated at *D*. To do this, they may be placed on a vibrating inclined plate *E* so that they pass through the opening at *F* into the chute. An oscillating brush at *G* can be used to disturb the pieces and break up any fixed arrangement. When the pieces have passed through into the chute *D*, the cup sides will not face in the same direction—some will be one way and some another. Referring to the enlarged view at *H*, the end of the chute is seen at *K* with one piece *L* entering the selector, and another following it at *M*. The selector revolves intermittently in the direction shown by the arrow at *N*. There are six slots equidistantly placed in the edge of the selector, and a guard plate covers its face, as shown at *O* in the sectional view. As the selector revolves, it takes one piece at a time from the chute and carries it around to the point *P*. If the piece has entered in the position shown at *Q*, it drops down through the chute *R*, but if it has entered in the reverse position as at *S*, it is carried around to the next station *T* and drops through the other chute *U*.

The mechanism governing this is simple. The revolving selector *V* has at each one of the six slots a spring plunger *W*, at the end of which there is a hardened roll *X* which travels around the circular plate *Y*. This plate is continuous except at the point *P*, where it is interrupted. If the cups face in the direction *Q*, the light spring behind plunger *W* simply throws the piece out into the chute at *R*, but if the cup lies as at *S*, the plunger enters the cup and prevents it from dropping until the selector has passed that point. Before reaching *T*, roller *X* rides up again on plate *Y*, thus withdrawing the plunger and allowing the piece to drop into chute *U*. It is only necessary to twist the chutes *R* and *U* in opposite directions, making a quarter turn, to have both pieces come out facing the same way at the bottom of the chutes, at which point they can be easily handled as required. The spring behind the plunger must be very light in order to prevent friction when the pieces slide out.

Considerable expense can be saved by using trays in which to arrange the pieces before feeding them into the machine, instead of using a hopper. Fig. 2 shows at *A* a form of tray that can be used, the pieces being rapidly spread out by hand so that only one layer is in the tray. Some of the pieces will be right side up, as shown at *B*, while others will be upside down, as at *C*. If the tray is made with one end *D* so that it can be pushed back far enough to allow one piece at a time to come through, this opening will serve as a gate, and the tray can be set up on an incline and against supports at *E* and *F*, so that the pieces will drop down one at a time into the chute *G*. From this they can go into the selector as in the preceding case.

Let us take another example of a disk *A* (Fig. 3). This is just like the other, except that it has no depression and could be handled from the hopper or from a stack by means of a reciprocating slide, as shown at *C* in Fig. 1, or by a rotating selector without the plunger. If flat pieces are being handled which are to be packed in bottles or boxes, the preceding method would be much too slow. Assuming that the tablet shown at *A* is to be deposited in a bottle, thirty pieces by count, it would be out of the question to use any such method as that mentioned. The pieces are to be dumped into a large hopper, several thousand at a time, as the requirements for production are such that not more than one second can be allowed for counting and putting them into the bottle. It would be difficult to make a counting device to operate as rapidly as this and with certainty, but the pieces could be weighed, or they could be arranged thirty in a row approximately 11¼ inches long, as shown at *B*. If they could be arranged this way, it would still be difficult to keep the chute full and deliver the pieces as rapidly as required.

If the pieces are dumped into a hopper, the previously demonstrated methods can be employed for making the parts come through an opening flat side down on an incline great enough so that they will slide down it to a gateway shown at *C*. This gateway is open at *D* over a rubber-faced disk *E* which revolves slowly. A guard strip *F* runs across the revolving table at an angle, and there is also a guard at *G*, the lower end of which blends into the chute *H*. From point *K* to *L* there is just room enough for thirty pieces to

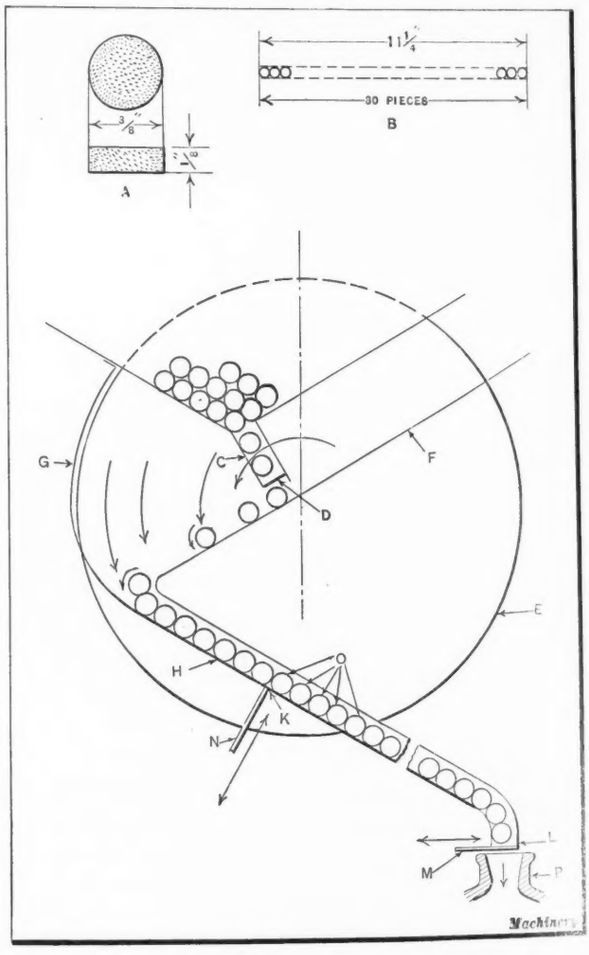


Fig. 3. Principle used in counting a Large Number of Pieces in a Very Short Time

lie. In operation, as the pieces drop through on the disk at *D*, the circular movement combined with gravity causes the pieces to roll rapidly down the incline and into the chute *H* until they have filled it completely. They will then back up against the guard *G* until relieved by the opening of valve *M*. This is timed so that, as it opens, another valve at *N* closes. As there are four or five pieces *O* still in contact with the rubber face of the disk, these will receive a rapid movement from it, pushing out those ahead so all the thirty pieces will shoot into the mouth of the bottle *P*.

Care must be taken in designing a mechanism of this sort to work out the important points by means of a model, as otherwise it will not function satisfactorily. A slight change in the angle of the guard plates, chutes, and the speed of the rotating disk make a great difference in the operation, but if the principle is understood, it is comparatively easy to make up a simple model which can be used for demonstrating purposes and to obtain the right relation of the various guards and chutes.

Fig. 5 shows at *A* a pasteboard box containing twenty-four tablets of the same shape as the previous example. They are arranged in the box in layers, as shown at *B*. The problem is to take the pieces from a hopper, arrange them in the box as shown, and put on the cover *E*. The production required is not less than twenty boxes per minute, and therefore not over one second must be consumed in putting in each layer. Arranging the pieces and putting them in the box is not particularly difficult, but we must also feed the boxes and covers into position and put on a cover. It is advisable to use two sets of chutes for the two layers in the box; this can be done easily enough, although care must be taken to provide a sufficient supply so that both chutes will be kept full and still have a reserve. By using two chutes, one layer is put into the box which then moves over to the other chute and receives the second layer. If the chutes are arranged properly, the production time will be only that required for putting in one layer.

The arrangement for feeding is simple, and needs but a brief description. The tablets lie in a nesting device, a part of which is shown at *F*. They are held back by a rubber cowl *G*, and lie between guides shown in the end view *H*. These guides are open at the bottom and contain long steel

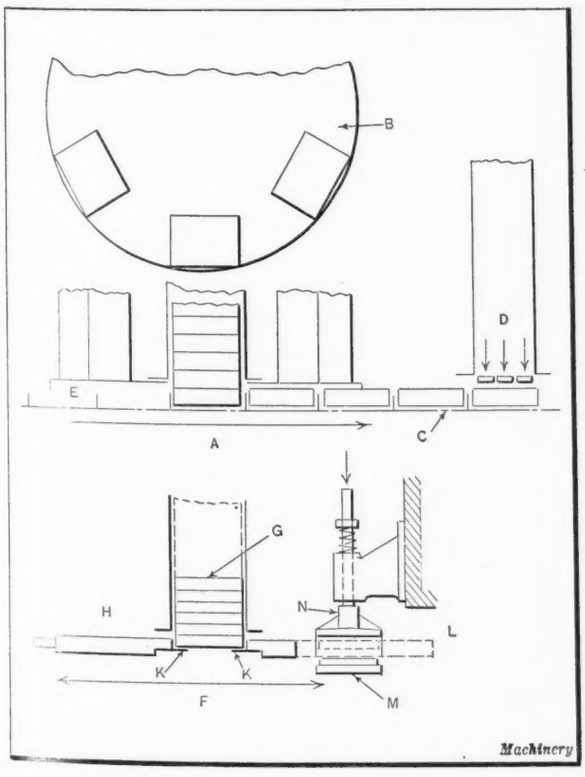


Fig. 4. Feeding the Boxes into the Machine and putting on the Covers

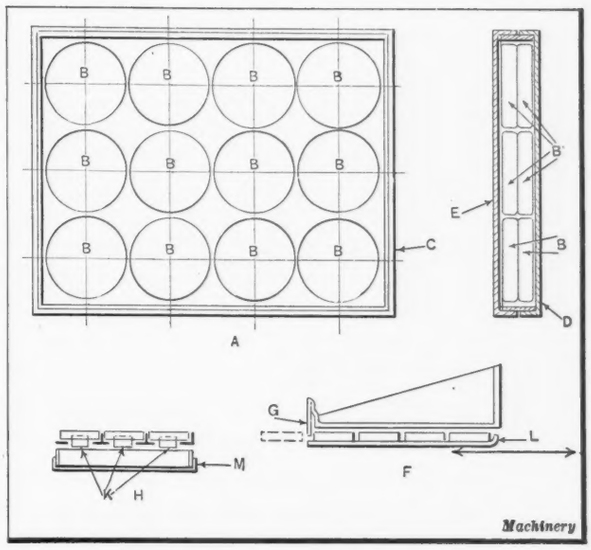


Fig. 5. Method of packing Pieces into Box

fingers *K*, having a hook on the end at *L*. At the proper time these fingers move forward over the box *M*, pulling with them the tablets, which pass under the cowl *G*. The fingers *K* then move backward again, and as they do so, the cowl *G* restrains the pieces from following, and they drop into the box one after the other in their proper arrangement. It is advisable to make the fingers lie as close to the top of the box as possible, in order to minimize the amount of drop.

Let us now consider the handling of the box and cover. As both of these are rectangular and regular in shape, it is not difficult to arrange a feeding device for them, but the putting on of the cover is more difficult.

If we take up one thing at a time, and decide to load the boxes from a stack, as shown at *A* in Fig. 4, we must realize that even with fifty boxes to a stack, a new magazine full would be required about every two minutes and a half. Therefore, it may be well to arrange for an indexing holder *B* containing six magazines, which can be quickly removed and replaced when empty. A device can be made which will index the table one station at every fifty strokes, either (1) by using a ratchet and pawl and a dog, which will drop into an index-plate at the proper time; (2) by putting exactly fifty holders on the conveyor belt and using a suitable dog on the side to index the table; or (3) by means of a cam. The first or third method is to be preferred.

The conveyor belt *C* removes the boxes one at a time by an intermittent movement, and carries them along to the first loading station *D*, at which point the first layer of tablets is put in by the method previously described. The conveyor is arranged with cross-pieces *E* spaced only a trifle further apart than the width of the box. As it passes under the magazine it stops, allows one box to drop, and continues to do this regularly.

We have now found a method for handling boxes and putting in the tablets, and it only remains to put on the cover. By arranging the covers in a stack of similar form to that used for the boxes, a reciprocating slide can be used to remove them from the bottom of the stack, as shown by the diagram at *F*. The cover *G* drops into the slide *H* and lies on top of two flexible rubber strips *K* which prevent it from falling through. At the proper time, the slide reciprocates and takes the position shown by the dotted lines at *L*, the cover then being directly over a box full of tablets shown at *M*. A pusher *N* lies directly over the cover, and is used to press the latter down on the box. The control of this mechanism is obviously very simple and does not need detailed description.

There are other ways of putting on a cover, one of these being indicated in Fig. 6 at *A*. Here the chute is set at such an angle that one side of the cover hangs low enough to be

caught by the edge of the box *B* as it passes under it. A light rubber or cloth cowl at *C* drags over the cover as the conveyor pulls it through. This device might be satisfactory if it did not depend on gravity for the operation, but unless the covers are fairly heavy there is a possibility of a miss now and then.

The lower view shows still another method often used for picking up pieces of this sort. Here the covers fall down a curved chute and come to rest as indicated. A perforated suction plate picks up one cover by vacuum, moves it over to the box and presses it down by a vertical movement of the ram. This device is rather more complicated than the others, but could be made very satisfactory. The pneumatic method of handling can often be used for conditions of this kind, but care must be taken with any materials that lie close together and that are somewhat porous, as there is always a possibility of the suction going through more than one piece and picking up two, when only one is wanted.

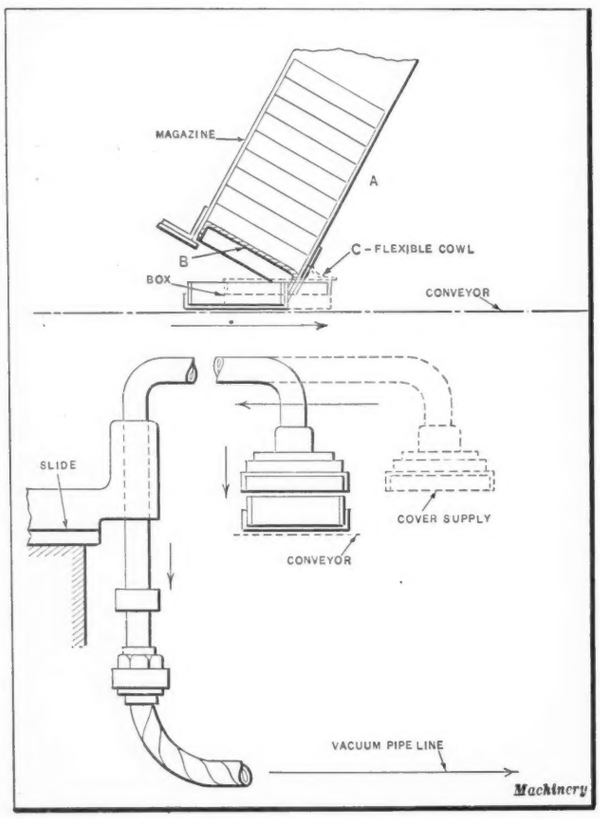


Fig. 6. Other Methods of putting the Covers on the Boxes

It will be noted that in working out this problem it was considered in unit form, and attention has not yet been given to the power application. The author believes that a great deal of unnecessary trouble is caused by the designer attempting to decide upon the method of driving and timing up a unit during the progress of the design. The units can be designed and located from the preliminary freehand sketch, and after their positions have been settled, the main driving shaft cams, levers, etc., can be placed most advantageously.

* * *

TURNING A 32-FOOT FLYWHEEL IN AN 8-INCH LATHE

By M. L. RIGGS

In the year 1891, the Ogden Iron Works, of Council Bluffs, Iowa, were engaged in the construction of a patented balanced valve steam engine. The specifications called for a flywheel 32 feet in diameter with a 36-inch face, a 9-inch hole for the shaft, and a single set of eight arms. The turning of this flywheel on an 8-inch lathe is perhaps the most interesting lathe job ever encountered by the writer.

As it was planned to ship the flywheel away for finishing, it was cast with cores in the hub and in the ring, which were so designed that the casting could be readily split into two sections by driving wedges into the cored holes. As the casting was being taken from the sand the writer chanced to remark that he could turn the wheel right there in the shop, with the result that he was given the job.

The first operation was the drilling of the lugs provided for bolting the two sections together, and the next the boring of a hole in the hub for the shaft. The latter operation was performed with a cylinder boring-bar, with the wheel lying flat on the ground. The wheel was next lowered edgewise into a pit about 16 feet deep which had been dug in the floor of the shop. Two 12- by 12-inch timbers were placed along the ground, one on each side of the wheel. These timbers were leveled up and the flywheel mounted on the main shaft of the engine which was supported by bearings secured to the timbers.

In order to drive the flywheel for the turning operation, a 1-inch rope was passed around the rim of the wheel and over the pulleys to the 18-inch driving pulley of a small steam engine that had been set up for the purpose. As the upper rope was carried over a pulley secured to the ceiling at a point about 30 feet from the wheel, a clear space was left at the front side of the wheel between the upper rope where it left the flywheel and the lower rope where it ran on the flywheel. The small 8-inch lathe could thus be set up in this space without interfering with the driving rope. In order to set the lathe bed parallel with the axis of the flywheel, lag-screws were screwed into each supporting timber at points located on each side of the flywheel face by measuring from the shaft where it projected from the flywheel hub at each side. The legs and tailstock were removed from the lathe, and its bed clamped in place on the timbers so that the back of the bed was in contact with two lag-screws that had been screwed into the timbers. The lathe bed was then fastened down in such a manner as to prevent it from tipping or changing its position.

The tool used in turning the flywheel was ¾ inch wide, 2 inches high, and 1 foot long, and was clamped to the cross-feed saddle of the lathe after removing the regular toolpost. A solid block of wood was placed between the rear end of the tool and the lathe carriage, and the tool held down by means of clamps and bolts. In order to crown the face of the flywheel, the lathe was set at an angle by placing a piece of iron bar of the proper thickness between the bed and one of the lag-screws, so that one-half of the flywheel face could be turned off at an angle; the piece of iron bar was then placed between the lathe bed and the other lag-screw for turning the other half of the flywheel.

The edges of the flywheel rim were also finished, one at a time, by turning the lathe bed around so that it rested in a longitudinal position on one of the timbers that supported the flywheel shaft. The same procedure was followed in facing the flywheel hub, it being necessary, however, to run the engine at a higher speed while the hub facing operation was being performed, in order to obtain a suitable cutting speed.

The lathe headstock, which was allowed to remain on the bed during the turning operations, was used to drive the feed mechanism. The spindle of the lathe was revolved at a very slow speed by employing a suitable combination of pulleys driven from the lineshaft. When the turning operations had been completed, the flywheel was split into two pieces by driving wedges into the cored holes previously referred to. After the wheel was broken apart, the rough edges on the inside of the hub were chipped and filed to give smooth corners and permit drawing the hub very tight about the shaft. The breaks in the rim were not finished or smoothed, and so made a perfect joint when reassembled. About nine or ten days were required for finishing the flywheel. As a whole, the job was very satisfactory and a great saving was realized, as compared with what the cost would have been if the flywheel had been shipped to some other shop for machining.

Grinding Fixture with Tilting Work-holder

By ROBERT P. SCHMIDTCHEN

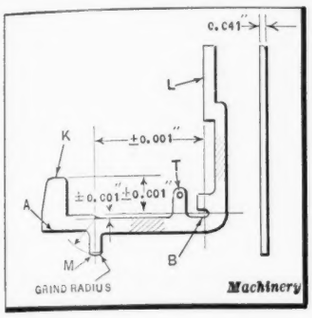


Fig. 1. Lever used in Telegraphic Instrument

THE fixture illustrated in this article is used in grinding three different surfaces on the lever shown in Fig. 1, which are required to be correctly located with respect to each other within limits of plus or minus 0.001 inch. This lever is one of the important parts of a complicated telegraphic instrument. It is made of vanadium steel, and is hardened all over, except at the shaded portions which are required to be annealed in order to permit straightening in case the lever is distorted in hardening.

Originally three different fixtures were employed in grinding the levers, each of which accommodated only one lever at a time. When these fixtures were in use, a great many pieces failed to pass inspection, and the production rate was so low that the job was not a profitable one. As an order was received for 50,000 pieces and the prospect of obtaining large additional orders was good, an effort was made to provide some means of increasing production and at the same time reducing the number of rejected parts, with the result that the fixture shown in Fig. 2 was developed.

Experience had shown that the number of rejects was greater when the parts required several different settings or transfers from one fixture to another than when they could be completely machined at one setting. The difficulty of keeping the grinding machine table set at a uniform distance from the grinding wheel was another factor that made it difficult to keep the work uniform and the number of parts rejected at a minimum. For these reasons the writer decided to design the grinding fixture in such a way that as many surfaces as possible could be ground without unclamping or changing the position of the work in the fixture and with as little changing of the wheel as possible. The work-holding fixture was practically built around the work, provision being made for locating the work-holding member in different positions to bring the surfaces to be ground into the proper position under the grinding wheel.

The fixture is designed to hold 100 levers, although the first fixture of this type held only 40 pieces. The original fixture was not provided with the bushings and plugs *N*, *O*, and *S*, which are part of the fixture shown in Fig. 2, and the use of these plugs greatly facilitated the tilting or relocating of the work-holding member in different positions. The use of this member also eliminated the necessity for cleaning the grinding machine table after each grinding operation. In the original fixture, the work-holding member *A*, Fig. 4, was only located in the main body of the fixture *B* when grinding the work to the radius *M*, Fig. 1, while for the other operations it was placed directly on the grinding machine table. The work-holding member of the fixture shown in Fig. 2 is divided into four sections each

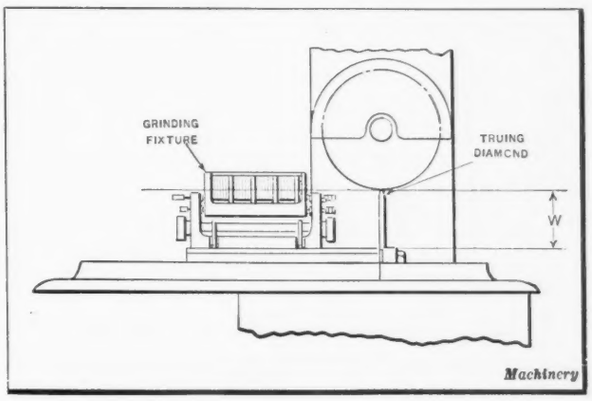


Fig. 3. Diagram showing Positions of Fixture and Truing Diamond on Grinder Table

of which holds twenty-five pieces. The main locating points for the work are at *A* and *B*, Figs. 1 and 2.

Preliminary Operations on Levers

After being blanked, the work is put through a shaving die in order to make the corners as sharp as possible. The next operation is that of drilling the small hole *T*, Fig. 1. The pieces are then oil-hardened and tempered. They are next straightened to fit a gage provided for the purpose, after which they are ground on both sides on a disk surface grinder to a thickness of 0.041 inch. After the slot *B* is

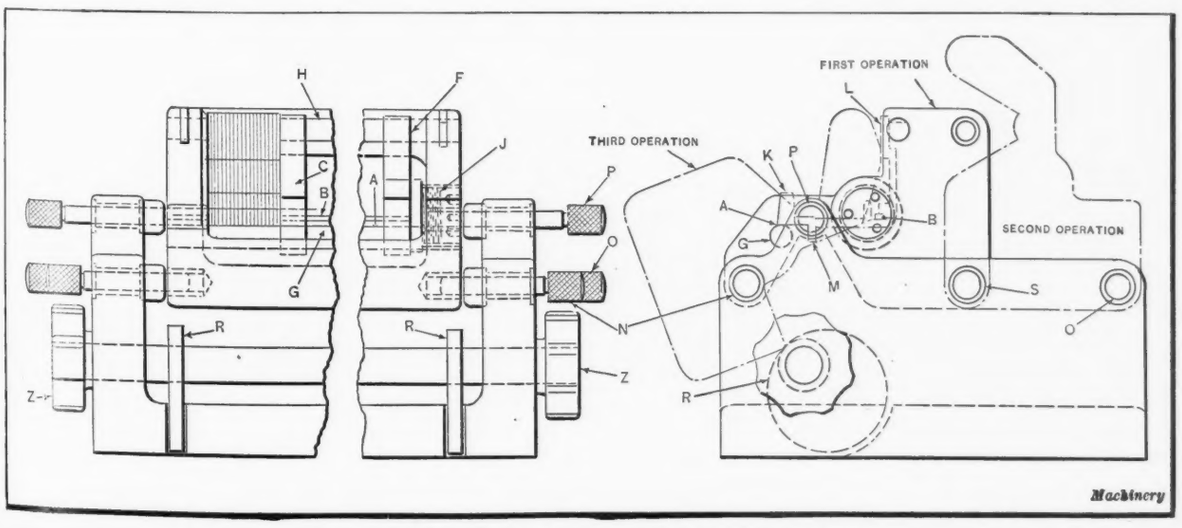


Fig. 2. Fixture used in grinding Levers like that shown in Fig. 1

lapped to a width of 0.062 inch, the levers are ready to be placed in the fixture for grinding. As the locating strips placed in the slots *B* would be too frail to support 100 pieces without sagging at the middle point, four supporting blocks were provided, two of which are shown at *C* and *F*, Fig. 2. These supporting blocks can be moved freely on the bars *G* and *H*. The surface at *A* is the next most important locating point of the work, and is accurately positioned in the work-holding member by the bar *G*.

No complicated operations are involved in the construction of the fixture here described, and it can be readily made by any careful toolmaker. In Fig. 2 the fixture is shown with one division of the work-holding member filled with 25 pieces, while the other divisions which are not shown in full are unfilled. When the fixture is fully loaded, the threaded disk *J*, which is in contact with the supporting block *F*, is given a few turns to the right with a special wrench in order to clamp the levers in the fixture with just sufficient pressure to permit bringing them into positive contact with the locating bar *G* and the strips placed in slot *B* by tapping them with a piece of soft metal. After this is done, the disk *J* is securely tightened.

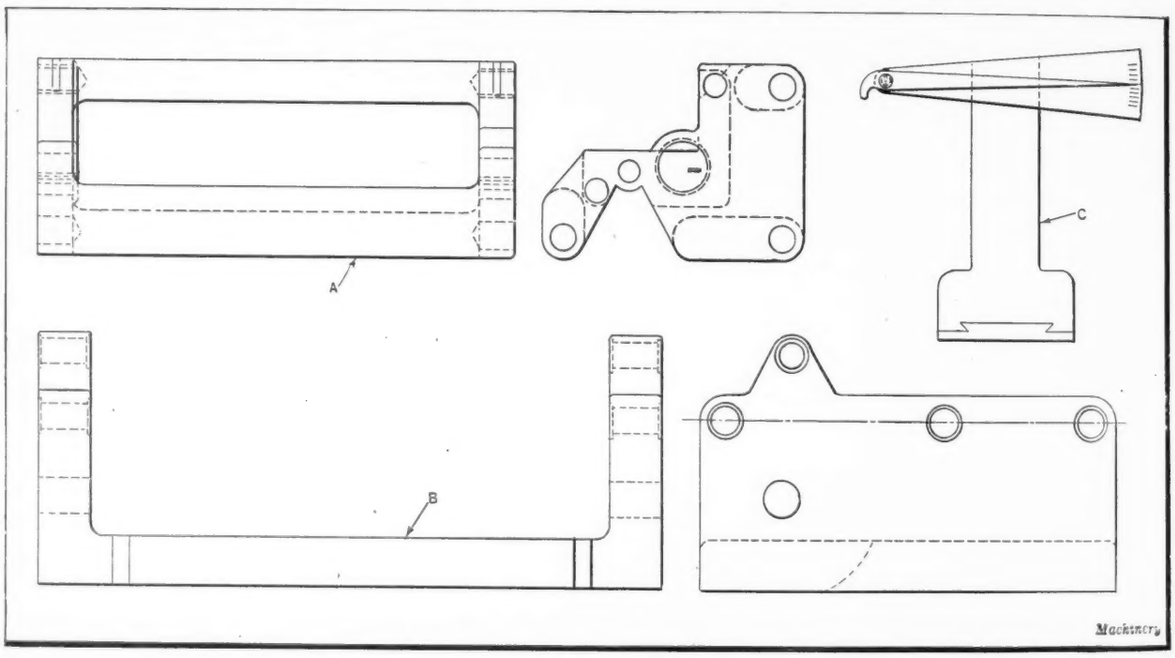


Fig. 4. (A) Work-holding Member of Grinding Fixture; (B) Main Body of Fixture; (C) Indicator used in setting Truing Diamond and inspecting Work

Performing the Grinding Operations

After the work is clamped in the fixture, the first operation is that of grinding the face at *K*, Fig. 2. The work-holding member of the fixture is positioned as indicated by the words "First operation." When surface *K* has been finished, the work-holding member is swung over to the position indicated for the second operation. In order to make this change, the plug *N* is removed and the plug *O* inserted to secure the work in the new position. After grinding the surface *L*, the work-holding member is placed in position for the third operation—grinding the radius *M*. For this operation, the plug *O* is removed and the work-holding member placed in position for the third operation, as indicated by the dot-and-dash lines. When in this position, the holder can be pivoted on pin *P* by turning the eccentric member *R* by means of the knob *Z* so that the surface *M* can be ground to the required radius. During this operation, the table is fed back and forth automatically while the work-holder is slowly pivoted on pin *P*.

The grinding wheel is kept in a good cutting condition, and the correct distance *W* (Fig. 3) between the wheel and table is maintained without adjusting the latter member by means of a truing diamond which is kept in a fixed position at one end of the table. This diamond is brought under the grinding wheel, and the latter lowered a few thousandths of an inch to permit its surface to be trued.

The indicator shown in the upper right-hand corner of Fig. 4 is used occasionally to test the accuracy of the work. This is simply an indicator or gage of the lever type, but as it is required to be used on a magnetic chuck, its base is made of stellite which is non-magnetic. This indicator is also used to set the truing diamond at the correct height from the table. It was found unnecessary to use a coolant when grinding the work in the fixture described, since it did not become heated sufficiently to draw a color. By providing an extra work-holding member, it would be possible to speed up production considerably, as one of the holders could be loaded while the other was in use.

* * *

LARGE NICHROME SHEETS

Among the exhibitions at the Steel Treaters' Exhibit in Boston late in September was a sheet of nichrome made by the Driver-Harris Co., Harrison, N. J. This sheet was 12 feet 8 inches long, 4 feet 9 inches wide and ⅜ inch thick, weighing about 1000 pounds. It is said to be the largest sheet of an alloy containing a high percentage of nickel and chromium yet produced. Plates of this size are used by some manufacturers for containers and furnace parts, and when perforated, as screens for use in chemical sifting and ore roasting apparatus, for services where temperatures between 1700 degrees F. and 2200 degrees F. are encountered. It is stated that the ultimate strength of nichrome at 200 degrees F. is 94,000 pounds per square inch; at 400 degrees F., 91,000 pounds per square inch; at 600 degrees F., 59,000 pounds per square inch; and at 800 degrees F., 32,000 pounds per square inch. Nichrome also shows a remarkable resistance to sulphuric and lactic acids.

* * *

Tests made by the Bureau of Mines at the Pittsburg Experiment Station indicate that the average motor vehicle wastes about 30 per cent of the heat value of the fuel used, because of incomplete combustion. These heat losses, it is said, are mainly due to improper carburetor adjustments, and by proper adjustment of carburetors for maximum power and efficiency, a large part of this loss could be avoided.

Intermittent Motion Mechanism

By A. W. HARRIS Manager, A. W. Harris Mfg. Co.

A. W. HARRIS is engaged in the development of special machines for making devices used in the growing and shipping of flowers and plants. The mechanisms described in this article were developed in this connection. Mr. Harris was born forty-four years ago near Willmar, Minn. After graduating from high school, he worked in a telephone office, and later enlisted in the U. S. Signal Corps for the Philippine service. Subsequently he was employed by the Minnesota Central Telephone Co. for fifteen years, rising to district manager. He then became engaged in the work that led to the development of the special machinery now made by the A. W. Harris Mfg. Co.

As the action of automatic machinery in general is based upon intermittent movements so synchronized that one or more will perform a certain function and then rest while other movements do their part, it is evident that intermittent movements are actually the brain of an automatic machine. There are only two main movements—reciprocating and rotary. Reciprocating movement is always intermittent, while rotary motion, unless modified in some way, is continuous. From various combinations of these two, all the complicated movements used in machinery are composed.

The intermittent movement to be described is not only of the rotary type, but it will give any variation of intermittent motion that may be required. With it, any number of revolutions or any fractional part of a revolution may be followed by a period of rest equivalent to any number of revolutions or any fractional part of a revolution. The combination of these movements may be varied in any way, and a series of different motion periods followed by required rest periods.

Simple Arrangement of the Intermittent Motion

This new movement is only a new combination of old principles. In a simple form, it consists of a clutch member the clutch pin of which is either engaged or disengaged from an adjoining gear by means of a mechanism that may be so arranged as to provide for periods of rest or action to suit all kinds of operating requirements. A simple design of this movement is shown in Fig. 1. On driving shaft *A* is mounted a gear *B* which meshes with and imparts continuous rotary movement to a gear *C* mounted loosely on a shaft *D*. Shaft *D* receives an intermittent movement, the periods of which may be varied by changing the ratio of the gears *B* and *C* and the stop periods by the same and other means.

A clutch body is secured to shaft *D* and is provided with a pin *E* which is free to slide parallel to shaft *D* and is adapted to enter periodically one of a series of holes in gear *C*, thus locking the clutch body and gear together. Pin *E* is actuated by bellcrank lever *F*, which is pivoted to the clutch body. One end of lever *F* engages a shouldered slot in pin *E*, and the other forked end is connected to a pivoted releasing dog *G*. Pivot *H* of dog *G* is in a plane at right angles to the pivot of bellcrank lever *F*. The dog is mounted in a slotted recess in the clutch body, and coincides with its circumference when in a compressed position.

Tension spring *I* tends to push the projection *J* of the dog outward, thus exerting pressure through bellcrank lever *F*, on the clutch pin *E* and forcing it toward gear *C*. At the stop periods, clutch pin *E* is held away from gear *C* by the engagement of cam arm *K* with projection *J* of dog *G*. In this position the pin projects beyond the end of the clutch body in a position to engage a locking recess in a stationary lug *L*.

In operation, this simple form of intermittent motion releases the clutch and stops shaft *D* after each single revolution, by means of cam arm *K*, which engages and depresses the dog *G*. As the cam arm *K* is removed from the dog, the spring *I* forces the clutch pin *E* against the side of revolving gear *C*, in a position to enter a slot or hole in the side of this gear. Assuming the ratio of the gears to be 24 to 28, the camshaft gear being four teeth larger than the clutch shaft gear, the pause periods will be equivalent to four teeth or one-seventh of a revolution of the camshaft, after which a full revolution of the clutch shaft is effected by the remaining twenty-four teeth of the camshaft gear, thus again bringing the clutch and the cam arm in proper alignment for operation.

It thus follows that the stop period is equal to the difference in the circumference of the gears, measured in degrees, and that a series of

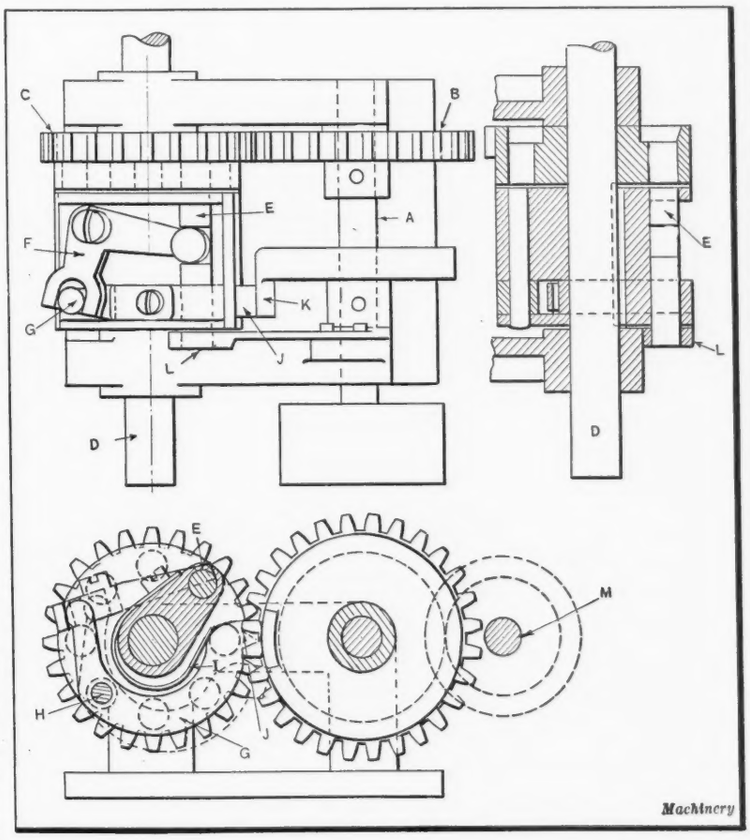


Fig. 1. Simple Form of Intermittent Movement Capable of One or More Whole Revolutions followed by Rest Periods Equivalent to One or More Whole Revolutions

clutch holes, spaced apart a distance equal in degrees to this difference has to be provided. By substituting gears of different ratios, and by changing the distance in degrees between the clutch holes accordingly, the periods of pauses relative to the periods of motion are altered. Instead of changing or closing the clutch holes, the length of the arc covered by cam K may be lengthened or shortened to obtain the same result. By providing another shaft M for the driving shaft, and by changing the gears to various other ratios, a great variety of motions and rest periods may be obtained.

With a single camshaft and a single clutch, one or more complete revolutions of the clutch shaft must always take place. If, however, two or more camshafts are provided for the clutch shaft, either fractional movements, whole revolutions, or combinations thereof may be obtained. Fig. 2 shows one such arrangement as applied to clutch shaft D for obtaining this result. One clutch O is keyed to the shaft, and another clutch P is loosely mounted on the shaft on the opposite side of the free-running gear Q. A second cam K_1 is mounted on the camshaft to control the operation of clutch P. The projecting face or arc of cam K_1 is opposite the projecting face of cam K with respect to the camshaft, and is nearly equal in degrees to the cut-away portion of cam K, as shown by the cross-sectional views.

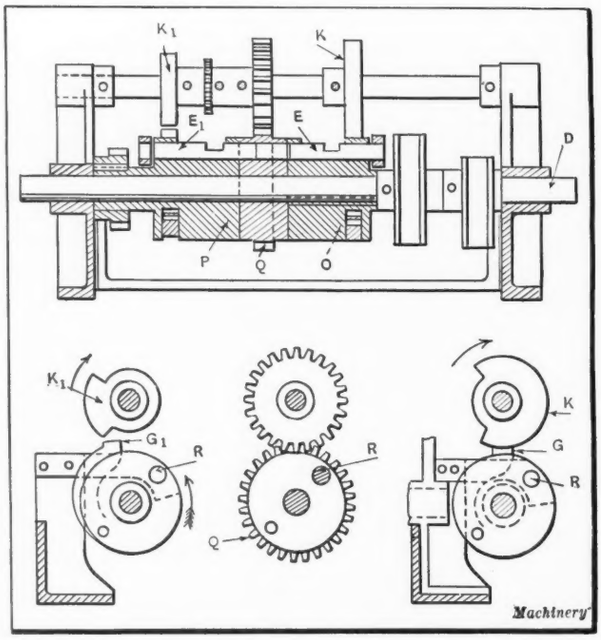


Fig. 2. Modification of Intermittent Mechanism for producing a Number of Adjustable Motion and Rest Periods Equivalent to Either Fractional or Whole Revolutions in Various Combinations

With this construction, when either one of the clutch dogs G or G_1 is released, the other is engaged by a cam face; therefore, when one clutch pin E is connected to the revolving clutch gear Q, the other pin is disconnected from the gear and in engagement with its stationary lock. A single clutch hole R for each clutch pin is required with this construction. During the rest period of shaft D, the clutch P and gear Q are revolving together loosely on their shaft, and when this shaft is rotated, the clutch P is at rest. For the gear ratio shown, out of six revolutions of gear Q the shaft will revolve two consecutive revolutions and rest for four revolutions. During the two revolutions of the shaft, the clutch P will rest and during the following four revolutions of gear Q the shaft will rest and the clutch P will revolve.

Provision for Rest Period Equivalent to Several Revolutions

When it is necessary to have the rest period extended for several revolutions, without having the gear ratio too great and the timing arm cam too long, an independent means for locking the clutch bolt and holding it from entering the

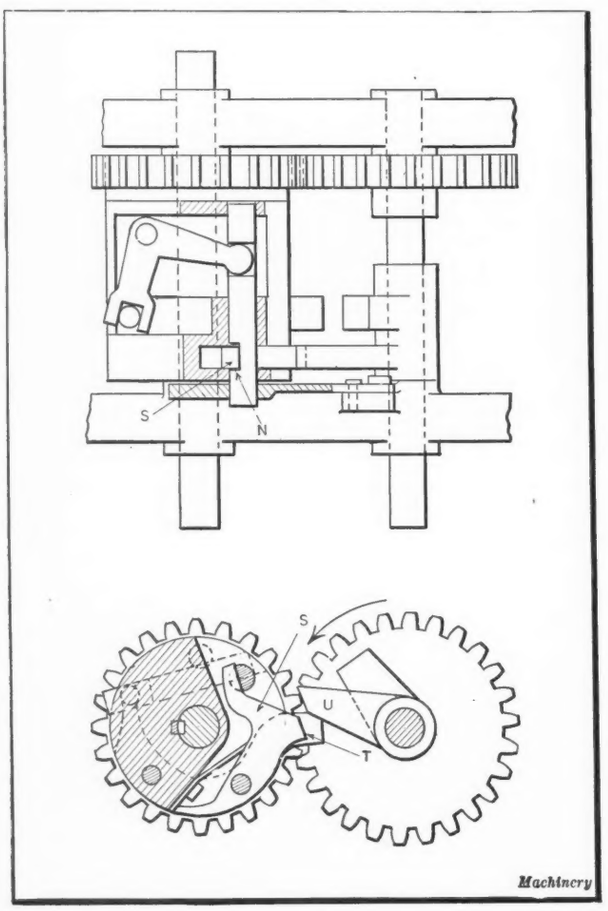


Fig. 3. Intermittent Motion with Means for extending the Rest Period

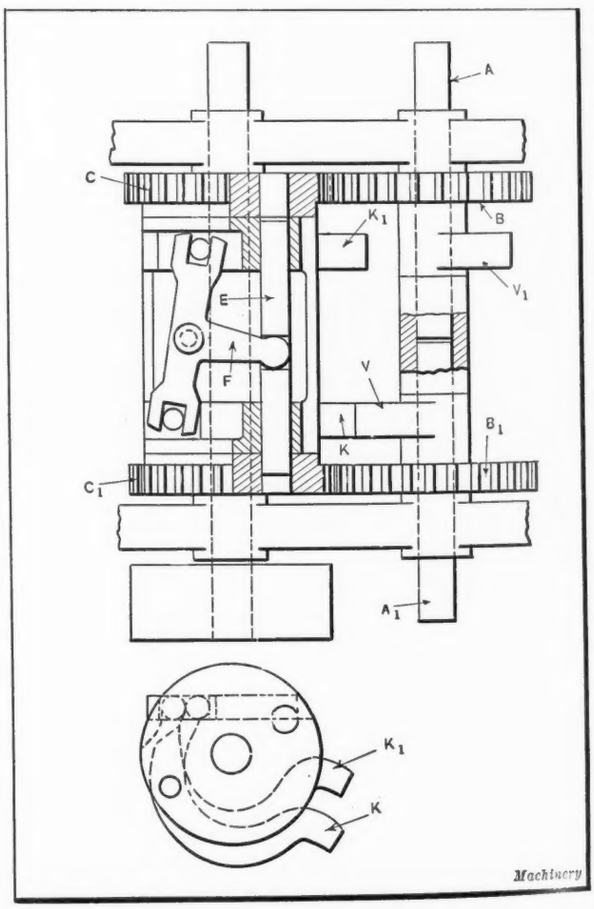


Fig. 4. Design for Starting One Mechanism at the Instant Another Stops

faceplate may be provided. The clutch body and pin are slightly lengthened and a second notch N, Fig. 3, is provided in the pin. A pivoted locking latch S drops into notch N when the clutch pin is in the locked position. This locking latch has a spring which tends to force it into notch N. A projecting end T extends beyond the peripheral line of the clutch member and in the path of a cam arm U. At a predetermined moment cam arm U engages the projecting end T of the latch and releases it from notch N, permitting the clutch pin to enter the rotating clutch member and start the clutch.

Design for Starting One Mechanism the Instant Another Stops

A modified form of clutch, useful where it is necessary to start one mechanism immediately after another is stopped, either in the same or in an opposite direction, is shown in Fig. 4. Two clutch levers K and K_1 are arranged in a recessed slot at each end of the clutch body. The clutch pin E has a central notch in which rests the rounded head of an arm of a T-shaped lever F pivoted centrally to the clutch and having opposite extending crank-arms provided with slots engaging the clutch levers K and K_1.

With this construction the clutch body is the driving and running element, and the geared members B and C are the driven, intermittently rotating members of the clutch. Gears C and C_1 are in mesh with gears B and B_1, mounted on shafts A and A_1 to which rotation is transmitted. Shafts A and A_1 carry cam arms V_1 and V, which, when they rotate, contact with the projecting ends of the levers K_1 and K, and throw the clutch pin E into and out of driving connection with the gears C and C_1. It will be seen that when one of these gears is disengaged from the clutch pin, the other gear is immediately engaged; therefore, when one of the shafts A or A_1 is in operation, the other is stationary. The duration of the periods of motion and rest is determined by the gear ratios and length of contact between the cam arms V and V_1 and clutch levers K and K_1, and may be different for each of the shafts.

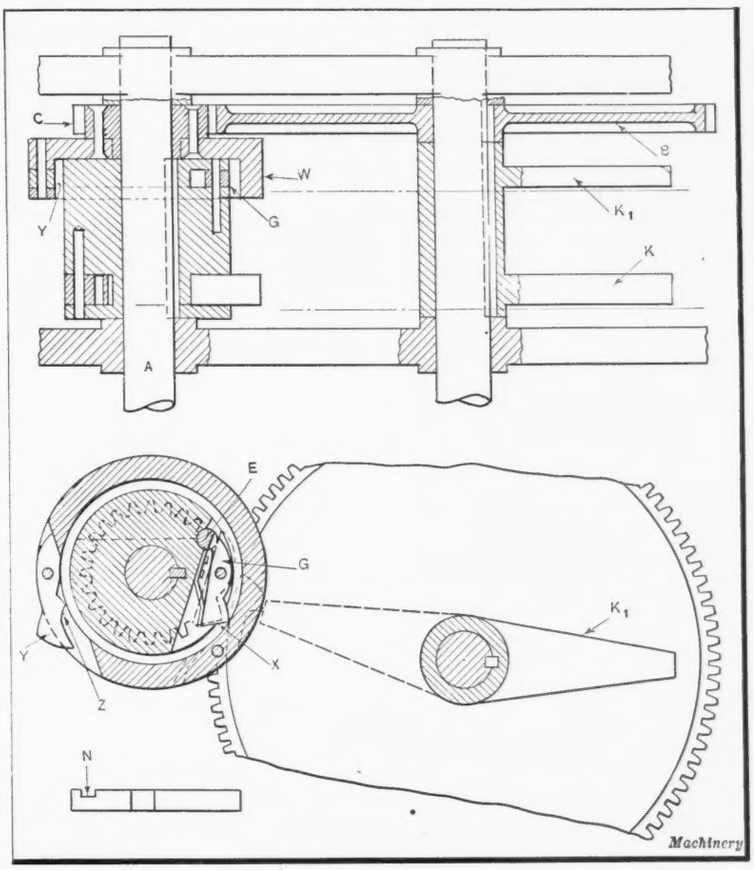


Fig. 5. A Modified Clutch Construction by which Prolonged Periods of Combined Motion and Rest are secured

Arrangement for Prolonged Rest Periods

A clutch modified in some particulars to obtain prolonged rest periods for the clutch body and shaft is shown in Fig. 5. By reference to Fig. 3 it will be seen that the latch S when locking the clutch pin from connection with the running member of the clutch, stops with the clutch body in position for the engagement of cam arm U. This stoppage limits the number of revolutions that the contacting cam arm may make before it again engages the latch to start the clutch. By providing an auxiliary releasing dog, connected to the running clutch member and controlled by a rotating cam arm, periods of rest as long as of movement may be procured by suitable speed ratios between the clutch and controller arms.

An enlarged annular clutch member W (Fig. 5) is secured to the gear C. A locking latch G for the clutch pin E is pivoted to the clutch body. One end of the latch engages a notch N in the pin when the pin is withdrawn from the clutch member W, and the other end of G is provided with a beveled catch X which projects outward beyond the edge of the clutch body when the latch engages notch N. A spring tends to hold the latch in this position. The auxiliary or latch-releasing dog Y is pivoted in a slot in the flange of the clutch member W. A beveled lug Z on dog Y projects inward, and when depressed, contacts with the catch X of latch G at a certain point of each revolution of the clutch member W, when the main clutch body is at rest. The releasing dog is also provided with an outer cam portion at end Y, which, due to centrifugal force, normally projects beyond the outer circumference of the clutch member W while the opposite end bears against a stop.

The mechanism for withdrawing clutch pin E from the running clutch member and locking the clutch body against rotation is identical with the mechanism previously described, and is controlled by a cam arm K fastened to a constantly running shaft, which carries a large gear B meshing with the small gear C. A second cam arm K_1 periodically contacts with and depresses the releasing dog Y just when the catch X and lug Z pass each other. When this occurs, latch G is disengaged from clutch pin E, permitting the pin to enter a hole in the running clutch member W, and starting the clutch body and shaft A. The number of revolutions that gear C may make between the disengagement and re-engagement of the clutch is accurately controlled by the ratio of gears B and C.

Application to an Automatic Machine

A general view of an intermittent motion applied to an automatic paper band machine is shown in Fig. 6. Without this new intermittent movement, it would either have been impossible to secure some of the required functions or the necessary means would have complicated the machine so much as to make it useless. This machine with the intermittent motion has been in use for over six years, and is working as well today as when new. The following intermittent movements are required: First, a revolution followed by a rest period equivalent to a revolution; second, one-half revolution followed by a rest period equivalent to one-third revolution; third, one-half revolution followed by a rest period of one-fifth revolution, followed by one-half revolution, followed by a rest period equal to four-fifths revolution; fourth, a counting movement which causes the machine to make 250 revolutions, producing 250 boxes which

are packed in a carton, after which the main machine is stopped for a period equal to 14 revolutions, or long enough to remove the full carton and place an empty one in position.

The gears are equal in size, and two cam or timing arms K and K_1 are placed 180 degrees apart. The middle gear is the driving member and runs free on the shaft A. The stop member L has two holes in it 180 degrees apart, and is fastened to an arm which is pivoted to a stationary part of the machine and is held against the clutch by a spring. This is necessary to eliminate backlash after the locking pin is withdrawn from the faceplate. In action, when the locking pin moves, the stop member is pushed away from the clutch until this pin moves to the hole in the stop plate, which happens only when the pin is completely withdrawn from the faceplate. The clutch is fastened to the driving shaft A. The locking pin is shown at E, and the dog G which operates it connects with bellcrank F.

This particular view shows the lower arm K_1 coming into contact with dog G. As this movement progresses, the pin

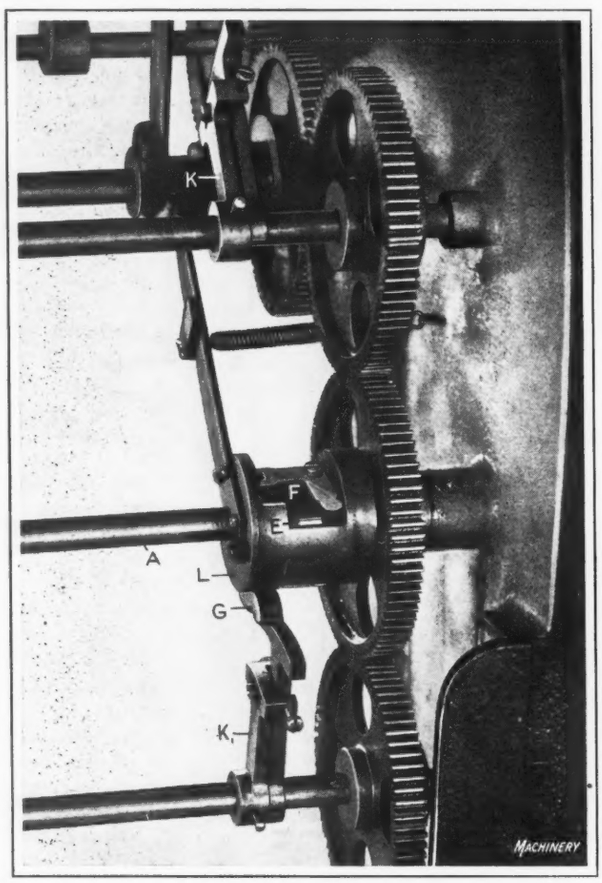


Fig. 6. Intermittent Motion applied to an Automatic Machine

is withdrawn from the faceplate and pushes the stop L away from the clutch until the clutch is rotated to its stop position; when the pin has reached the hole in the stop, the stop springs back and prevents further rotation of the clutch. The other half of the movement is identical, with the exception that the upper timing arm K operates. The periods of rest are governed by the angles between the holes in the faceplates. To facilitate the adjustment of the point when the pin is completely removed from the faceplate, so that it will be directly opposite the hole in the stop, the position of the arc-shaped cams on the ends of the timing arms is made adjustable, so that the point of withdrawal can be advanced or retarded.

In the counting movement, the two gears have 264 and 53 teeth, and 264 revolutions of the small gear are required before a certain tooth will re-enter the same place in the large gear. With two timing arms, this period is divided into 250 revolutions, followed by a rest period equal to 14 revolutions. This period of 264 revolutions could be divided into periods having any number of revolutions followed by rest periods equal to the remaining revolutions, by changing the relative position of the timing arm but not replacing the gears. The locking pin is so made that when withdrawn from the faceplate it is held in position by a catch on the clutch until released by the second timing arm.

The product of nearly every automatic machine now in use is sold by number, and in a great many cases this number must either be counted or weighed. When it comes to automatically counting the required number, there will be found very few machines that will function correctly in constant use. Not only is this counting attachment applicable to new machinery, but, with few exceptions, it can be applied to machines now in use with only a slight modification of the machine itself. This intermittent movement has been operated at several hundred revolutions per minute without failure. It is not only universal in its application, but simple in operation and can be made strong without being unwieldy.

* * *

GERMAN MACHINERY INDUSTRIES

According to a communication from Vice-Consul Erik M. Magnuson of Stuttgart, Germany, published by the Department of Commerce, the ability of German machinery manufacturers to compete with those of other countries is impaired, not only on account of German prices being above the world market level in some instances, but also because of the apprehension of foreign buyers that the unsettled conditions prevailing in Germany may delay deliveries. This is an important factor in the machinery trade when it is considered that it takes months to build certain types of complicated machinery. Some manufacturers of standard types are keeping stocks abroad with which to supply their customers without delay, it is reported.

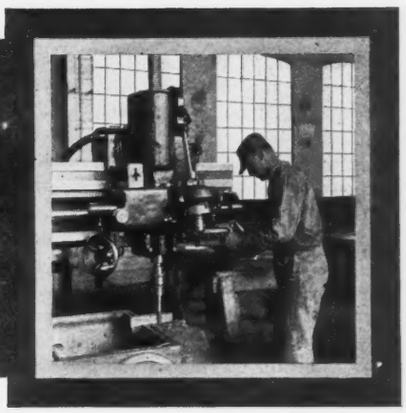
The Russian market does not appear at present to hold out reasonable prospects to German machine makers, although the worn-out machinery in Russia is in need of repairs and replacements. The monopoly of imports by the Russian Government makes transactions practically impossible, as the maker cannot get in touch with the buyer directly. The shortage of capital in Germany makes it imperative that goods be paid for at once, whereas the Soviet régime wants credit for long periods. For this reason many Russian orders for machinery have been placed elsewhere.

German machinery encounters chiefly British and American competition in the export field. Excessive costs of production making for high prices, the difficulty in guaranteeing deliveries, and the lack of facilities for offering liberal terms of payment are given as leading reasons for the inroads made on Germany's foreign trade by competing powers. Great difficulties are anticipated for the future. It is argued that if Germany wishes to hold her position among the world machinery markets, German machinery manufacturers will have to calculate very closely and eliminate methods used during the inflation period. Terms of payment and selling methods must also be adapted to circumstances, otherwise, it is stated, Germany will be automatically excluded from the world markets.

* * *

The president of a large manufacturing concern manufacturing a product, the sales of which, it is often believed, are hampered by the sales of automobiles, because many people cannot afford to indulge in two so-called semi-luxuries, recently stated in a letter to the Packard Motor Car Co.: "Our salesmen frequently report loss of sales due to the contemplated purchase or the maintenance of an automobile. We are unable to ascertain whether this loss is really as great as they say it is, as salesmen have a habit of shifting the blame to anything that is popular. On the other hand, this is balanced by the many great automobile companies employing thousands of men who may through their prosperity become purchasers of our product."

Letters on Practical Subjects



CUTTING FIGURE EIGHT OIL-GROOVES

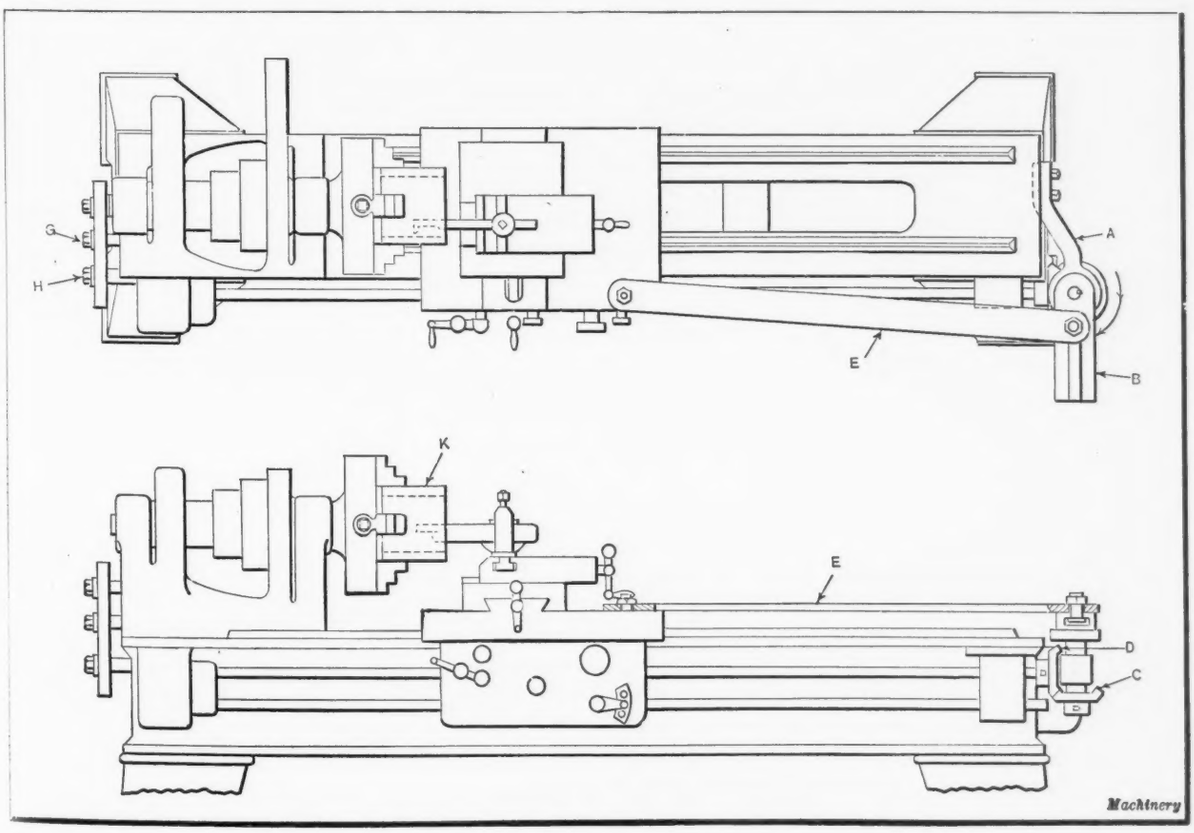
The cutting of figure eight endless oil-grooves in a bearing was accomplished by rigging up a lathe as shown in the accompanying illustration. The bracket *A* is fastened to the lathe bed at the tailstock end, so that it supports the eccentric arm *B* and the bevel gear *C*, both of which are keyed to the same shaft. Gear *C* meshes with a driving gear *D* which is keyed to the lead-screw on the lathe. All of the mechanism of the apron is disengaged from the lead- and feed-screws, so that the carriage is free to move on the ways. A connecting-rod *E* joins the carriage and the eccentric arm *B* so that the carriage will be moved back and forth on the ways when the eccentric arm is revolved.

As the carriage moves toward the headstock the tool cuts a right-hand spiral, and as the eccentric completes the revolution the carriage is moved toward the tailstock, causing the tool to cut a left-hand spiral and thus completing the cycle that results in turning a figure eight oil-groove in the bearing *K*. This motion continues, and the tool is fed in by means of the cross-slide until the groove is cut to the required depth. By changing the position of the stud that secures the end of connecting-rod *E* to arm *B*, the distance that the carriage will move may be changed to suit the length of the bearing. Adjustment for bearings of different diameters is taken care of by the cross-slide. Oil-grooves having any required helix angle may be cut by placing the proper gears on the studs *G* and *H*.

St. Louis, Mo. C. J. WEINGARTNER

PIERCING, FORMING AND CUTTING-OFF DIE

On page 864 of July MACHINERY there is a description of a progressive piercing, forming, and cutting-off die for a clip similar to the one shown at *A* in the upper right-hand corner of the accompanying illustration. While the die described in the article referred to has some good features, the writer believes that the one here described will cost less to build and will produce equally good work with less waste of stock. Even with a high labor cost, the rate at which the pieces are produced is such that the cost of the material is an item of far greater importance than the labor cost. As 3600 to 4500 pieces are required per day, it is evident that only a slight waste per piece will represent a consider-



Lathe equipped for cutting Figure Eight Oil-grooves

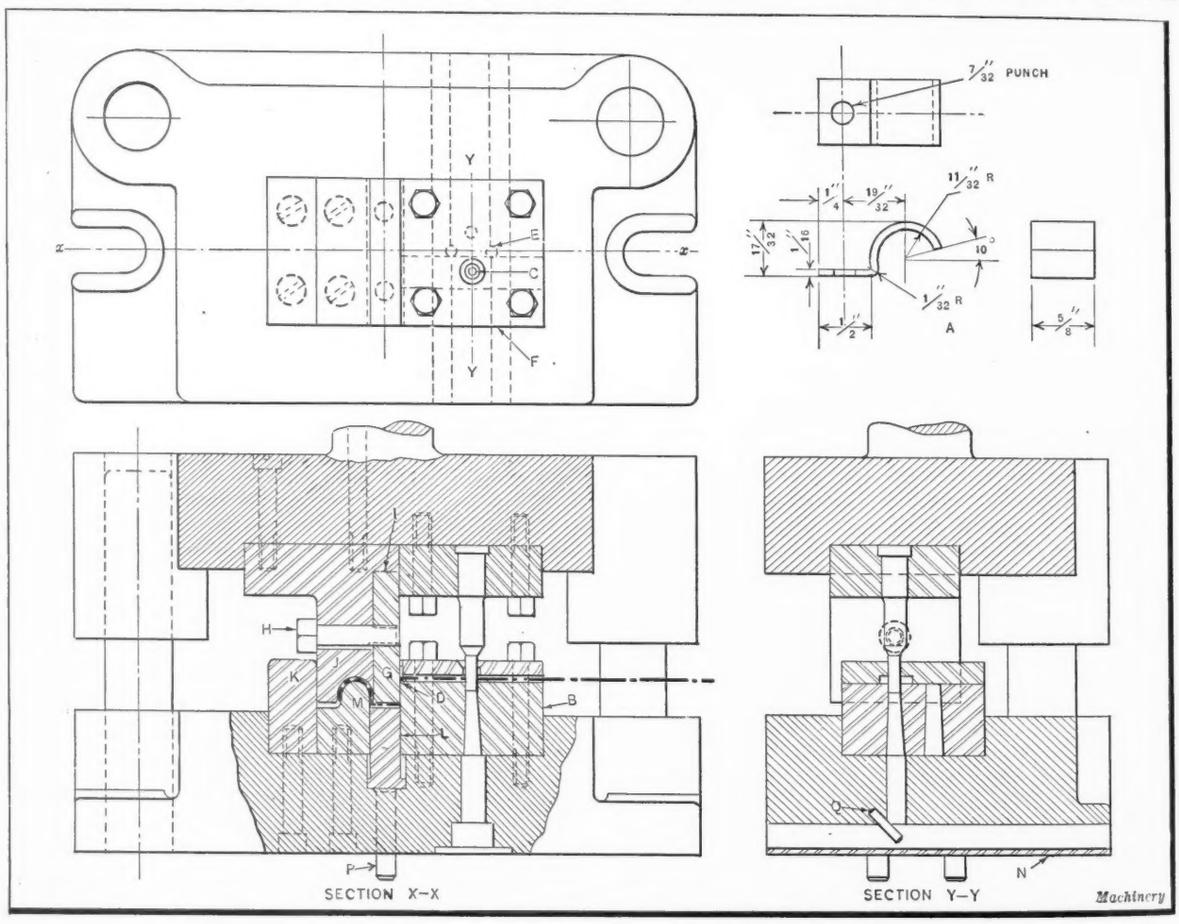
able amount in a year's time, whereas the labor cost of only 21 cents per 1000 pieces is of little importance as compared with the cost of the material.

The die here illustrated is very simple in construction and operation. The part shown at *B* is the piercing and cutting-off die. This part is exactly square and has four piercing holes—a construction which permits the die to be turned around 90 degrees after one hole and one edge are worn, so that a new piercing hole and cutting edge are made available without regrinding the die. This change in the position of the die can be repeated until all four piercing holes and cutting-off edges have become dull, after which the die can be removed and reground.

When the piercing hole *C* is used, the cutting edge *D* is in position for cutting off the pierced and formed part. Similarly, when the piercing hole *E* is used, the cutting edge *F* is in position for cutting off the part. The four cutting edges of the die are all ground, as is also the top surface of the die. In designing a die like this the first step is to determine the length of the blank. This can be done mathematically, the lengths of the straight and the curved portions being calculated separately and the results added to obtain the total length, which in this case was found to be 1.5879 inch. Since the distance from the end of the part to the center of the 7/32-inch hole is 1/4 inch, the distance from the piercing hole to the cutting-off edge is 1.5879 minus 0.250 or 1.3375 inch. This dimension must be accurate for all four sides.

The cutting-off punch *G* is made with a cutting edge on each of its four sides, and regrinding is unnecessary until all four cutting edges have become dull. This part is made square with a 3/8-inch tapped hole in the center, and is held in place by the cap-screw *H*. The cutting-off punch is ground on all four sides, which makes it necessary to place shims under the face *I* having a thickness equal to the amount of material removed from the two opposite faces; that is, if 0.005 inch is removed from each of the two sides, a shim 0.010 inch thick should be placed under face *I*. The forming punch *J* is backed up by stop *K*. The distance from the face of stop *K* to the edge of the cutting-off die is exactly the same as the length of the blank. After the part is cut off, it is held between the cutting-off punch and the pressure pad *L* while it is drawn around the die *M*. If necessary, a pilot-pin may be inserted in the cutting-off punch which will positively hold the blank in place. If a spring pad is used instead of a pressure pad, the pilot-pin is, of course, necessary, but if a spring pad is not employed, it is preferable to omit the pilot-pin, in which case the operator will not be required to take special precautions in starting a new strip.

The plate at *N* is provided to prevent the slugs punched from the 7/32-inch hole from falling into the holes in the bolster or under the pressure pad. The pressure pins that support or actuate pad *L* are shown at *P*. The pin *Q*, which is driven into the die-shoe at an angle, serves to deflect the slugs in such a manner that they will fall out at the back of the die. This pin also prevents the slugs from sticking together and coming through the die in the form of a continuous piece of wire which would clog up the die and cause the punch or die to be broken. The die is used in an inclined press so that the part as well as the slugs slide out into a receptacle at the back of the press. A U-shaped piece of sheet metal may be so positioned at the back of the die that it will separate the slugs from the parts. J. G. K.



Die for piercing, forming and cutting off Clip

DESIGNING TO FACILITATE MACHINE WORK

Needless expense and loss of time can often be avoided by taking into consideration the capacity of the machines on which a piece of work is to be handled before proceeding with the design. Of course, work cannot always be designed to suit the machines, but if the designer has on hand

a complete list or tables showing the maximum swings of the various lathes and their center distances, the length of shaper strokes, width between planer uprights, etc., he can easily determine within what limits the work must be kept in order to avoid the necessity of sending it to an outside shop.

Again, if the tool designer is supplied with a similar list of the capacities of the various machines in the tool-room, he can, in a measure, modify his designs to permit work to be handled in the tool-room that might otherwise be sent to the regular machine shop. For instance, jig bodies and die shoes, when made with a large radius at the corners, will come within the capacity of a given machine, whereas if the corners have very small radii, it will be necessary to employ a larger sized machine than would be available in the tool-room.

Another important factor that the designer should take into consideration is the manner in which the work is to be machined, especially if there are a number of duplicate cast-iron pieces to be made. In many instances, the provision of a clamping lug or rib in the design of the pattern for a casting, will greatly facilitate the machine work. While the designer may not be considered at fault for failing to consider such details as have been mentioned, he should, nevertheless, bear them in mind and assist in every way possible to make his designs practical from the production point of view before turning them over for the chief's O. K.

CHARLES HOMEWOOD
Ontario, Cal.

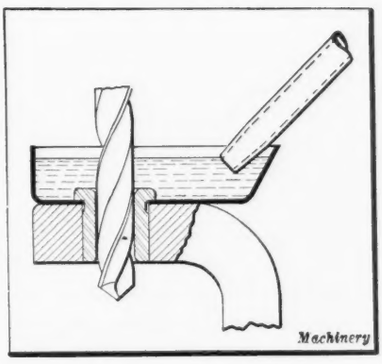


Fig. 1. Sheet-iron Coolant Basin

DRILL JIGS WITH BASINS FOR COOLANT

The conventional method of cooling drills is to direct the cooling compound on each drill through a separate flexible metal hose. Every individual hose is supplied with cooling liquid from a larger sized distributing pipe, fed by a pump attached to a reservoir. This system is quite expensive and not entirely practical, especially in cases where a large number of drills are used, as, for instance, on a multiple-spindle drilling machine or where multiple drill heads are attached to standard single-spindle drill presses.

The flexible hose is easily thrown out of its setting by flying chips, and constant attention of the operator is required to correct this condition. The same difficulty is experienced when solid pipes are provided for each drill. If the distance between the drill and the discharge end of the pipe is increased to avoid this trouble, the stream of liquid directed on the drill is scattered in all directions by the flying chips; consequently a very small quantity of compound reaches the required destination. Furthermore, a splash apron must be provided to prevent the operator from being wet by the flying compound. It is obvious that if an insufficient quantity of cooling liquid is delivered, the drills will become burned and dull in a much shorter time than if a good supply of the compound is constantly applied.

A better way to supply drills with a steady flood of com-

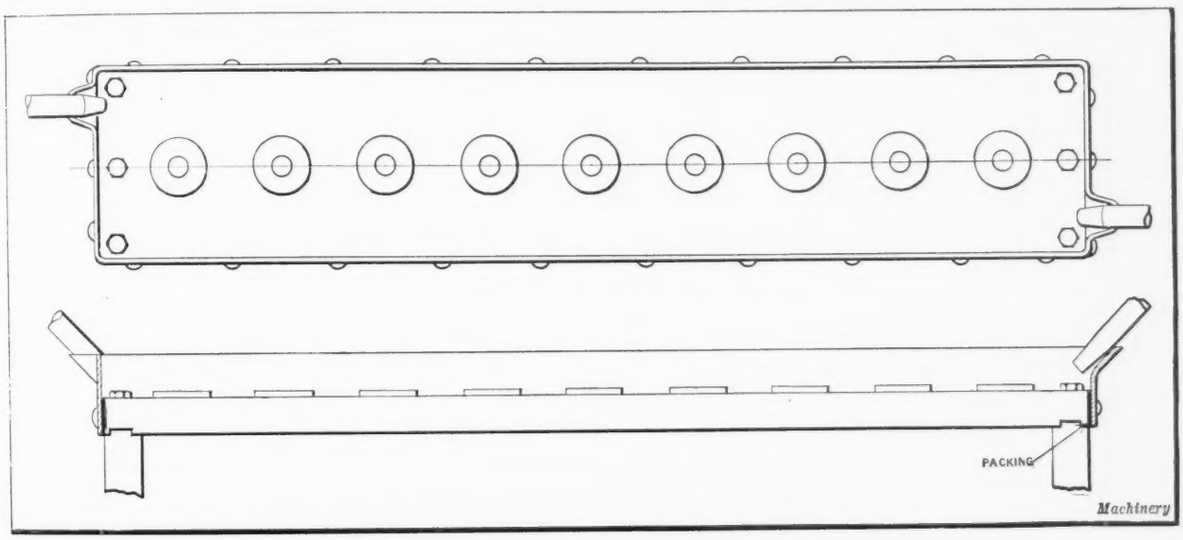


Fig. 2. Coolant Basin cast as Part of Jig Body

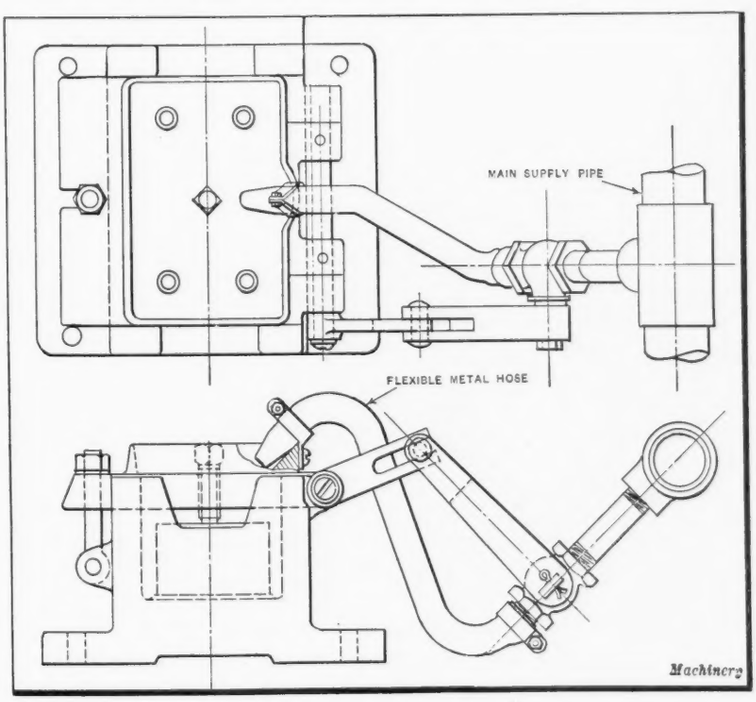


Fig. 3. Multiple-spindle Drill Jig equipped with Coolant Basin

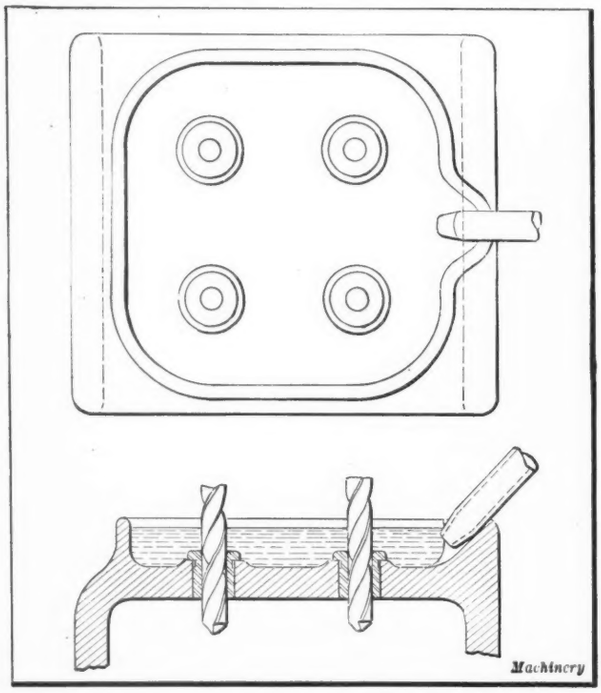


Fig. 4. Jig provided with Automatic Shut-off for Coolant

pound is to provide various shapes and sizes of basins on drill bushing brackets or plates, as the case may be. These basins, as will be noted by referring to the illustrations, are fed by only one pipe. The supply pipe must be equipped with a valve by which the flow of liquid can be regulated so that the basins are kept filled almost to their capacity all the time.

Fig. 1 shows a small sheet-iron basin attached to a bushing on a standard type single drill jig. If the bushing bracket is a casting, the basin can be incorporated right in the bracket, as shown in Fig. 2. Application of a sheet-metal coolant basin to a multiple-spindle drilling machine is shown in Fig. 3. In this case, instead of individual basins for each single drill, a larger basin that feeds all the bushings is used. This is filled by only one feed pipe, and requires no attention from the operator. An even distribution of the liquid to all drills is thus obtained without difficulty.

In case a steady stream of compound interferes with the reloading of a fixture, an automatic device for shutting off the supply of liquid can be arranged. To deliver the coolant to a multiple-drill box jig with tipping bushing plates is a difficult proposition in itself. If individual feed-pipes are used, their discharge ends must be a considerable distance from the drill so that the top or leaf of the jig can be opened. Jigs having bushing plates that must be tipped while reloading can be provided with a rubber or metallic flexible hose. This hose can be clamped to the basin and an automatic shut-off for the cooling compound attached, as shown in Fig. 4.

On multiple-spindle drilling machines, where the bushing plates are attached to the spindle head of the machine, a flexible hose might be clamped to the bushing plate so it will move with the plate to and from the cut. An automatic shut-off arrangement, as described before, could be applied to stop the stream of compound while the work is being changed. The various applications of cooling compound basins as outlined in the foregoing may also be used to advantage for reaming and tapping fixtures.

Cleveland, Ohio C. T. KETZ

UNIVERSAL JOINT OF SIMPLE CONSTRUCTION

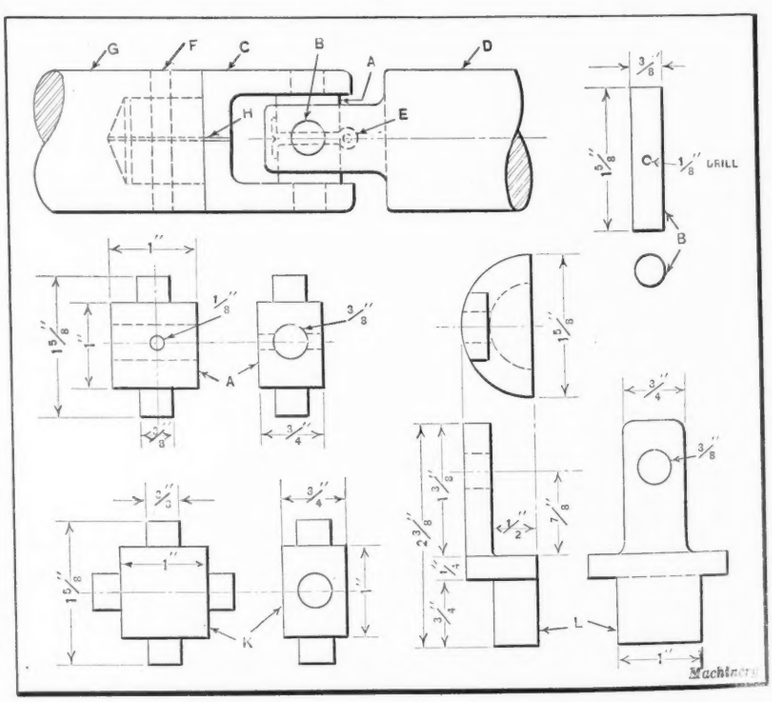
It is often necessary to transmit power or motion at an angle by means of a universal joint of some kind. Of the dozen or more types of joints in use, there are only a few that can be readily made with simple machine shop equipment. In the upper left-hand corner of the accompanying illustration is shown a universal joint that is durable and that can be easily made. The joint illustrated is quite a large one, but any size can be made with the same design by reducing or increasing the dimensions proportionately. The part *A* is known as the center block of the joint, and is made from rectangular stock or sometimes from square stock. The round ends are turned in a lathe, and then holes are drilled through the block at right angles to the round ends as shown.

The pin *B* fits the larger hole in block *A*, and is locked in place by the cotter-pin *E*. Part *C* is composed of two jaws like the one shown at *L* which are turned up in a lathe in one piece, shaped and slotted on a shaper, and then sawed through the middle into halves, after drilling the holes through the sides. These jaws are made in two pieces for ease in assembling, and one of them fits over each of the two turned ends of block *A*. The center-block is placed between the jaws, which are then slipped into the drilled hole in the end of shaft *G*. A shim *H* is placed between the halves of the jaw in order to fill the gap that was made by the saw, and the pin *F* is driven through to lock the parts together.

The other jaws, shown at *D*, are much simpler in construction than those just described. They can be shaped down from the end of a shaft without requiring any turning. These jaws are slipped over the center block *A* and the pin *B* is inserted and locked in place by means of the cotter-pin *E*.

A center block that can be used in place of the one shown at *A*, if desired, is shown at *K*. When this block is used, pin *B* and cotter-pin *E* are eliminated, but both sets of jaws must be made as shown at *C* in order to permit the joint to be assembled. Shafts *G* and *D* are made, of course, of a size to suit requirements. Joints constructed according to either method described will operate at an angle of 40 degrees, and only require a drop of oil now and then for lubricating purposes.

Indianapolis, Ind. WILLIAM F. SANDMANN



Assembly and Detail Views of a Universal Joint which is easily made

Shop and Drafting-room Kinks

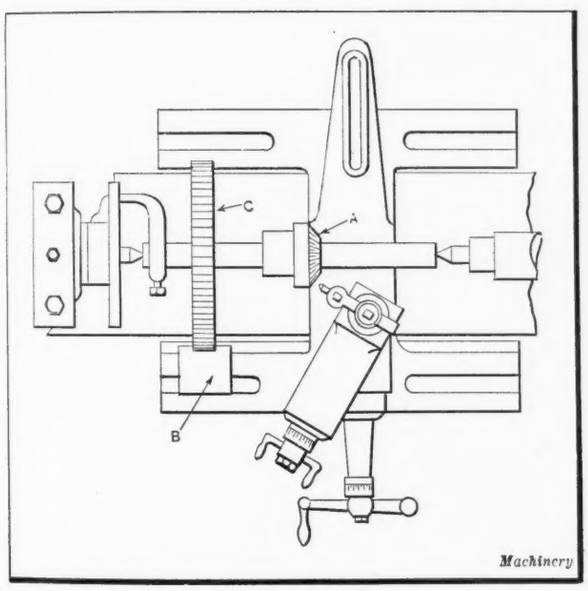
IMPROVING A DRAWING CABINET

Blueprints have a tendency to curl up when placed in the large drawers of a drawing cabinet. This curling of the edge at the back side of a drawer interferes with the opening and closing of the drawer and sometimes results in torn drawings. A simple and effective method of overcoming this trouble is to drive three or four nails into the back side of the drawer near the top. The back edge of the drawings or blueprints may be slipped under these nails which will prevent the edge from rising and being caught and torn when the drawer is opened.

Springfield, Vt. H. L. WHEELER

CUTTING GRADUATIONS IN A BRASS SHELL

In the accompanying illustration is shown a lathe equipped for cutting forty division lines on the conical surface of the brass shell *A*. One end of the arbor on which



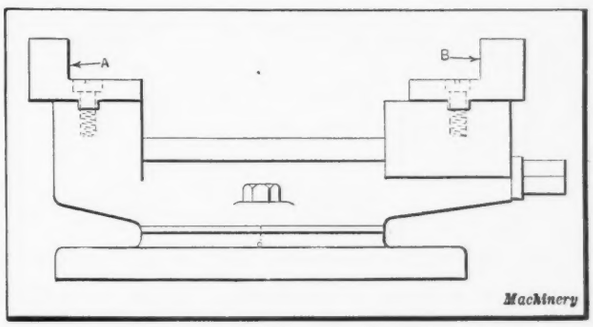
Lathe Set-up for cutting Graduations in a Brass Shell

the shell was turned was made to fit one of the change-gears of the lathe, the teeth of which were used as markers or indexing notches. The block shown at *B* mounted on the lathe carriage was made to serve as an index-pin, being brought into mesh in the space between two teeth and clamped there by means of the tailstock while moving the compound slide in and out, so that the scribing point of the tool held in the toolpost would make a fine graduation line on the conical surface of the work. To insure as great a degree of accuracy as possible, a gear *C* having eighty teeth was selected, so that it could be indexed two teeth for each graduation in the work.

Elmira, N. Y. CLYDE NAGLE

AUXILIARY JAWS FOR SHAPER VISE

A shaper vise equipped with auxiliary jaws like those shown at *A* and *B* in the accompanying illustration will often facilitate machining operations on light weight castings such as are used for jig bodies or a similar class of work that does not require heavy cuts. These auxiliary jaws greatly increase the capacity of the shaper vise, but it



Shaper Vise provided with Auxiliary Jaws to increase the Capacity

should be borne in mind that they will not stand so great a strain as the regular jaws, owing to the comparatively greater distance from the main body of the vise. The auxiliary jaws are made of machine steel with tongues machined to fit grooves cut in the top surfaces of the regular jaws. Three fillister-head screws are used to hold each of the auxiliary jaws in place.

Ontario, Cal. CHARLES HOMEWOOD

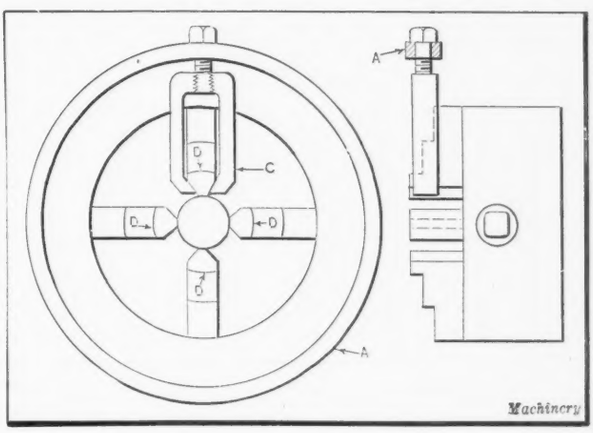
TRUING UP UNIVERSAL CHUCK JAWS

A device for setting the jaws of a universal chuck so that they can be accurately trued up is shown in the accompanying illustration. The purpose of the device is to take up any lost motion that may exist between the threads on the jaws and the scroll. This lost motion is taken up in the same manner as when the jaws are tightened on a piece of work.

In grinding the inner ends of the jaws, a ring *A* somewhat larger in diameter than the chuck, and having four equally spaced radial holes, is used in connection with four clamps like the one shown at *C*, to draw the jaws outward so that there is no lost motion between the threads on the jaws and the scroll.

For truing up the outer ends of the jaws to secure the same accurate results, all that is necessary is to place a ring over the smallest steps of the jaws at points *D*, and set the jaws against this ring, as would be done in chucking a piece of pipe on the inner surface. After the outer steps have been ground, the smaller ones may be trued up by placing rings on the outer steps and tightening the chuck jaws on the inside of the ring.

Watervliet, N. Y. MARTIN H. BALL

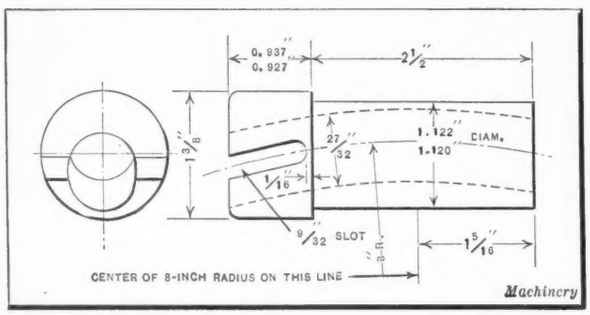


Ring and One of Four Clamps used in truing up Chuck Jaws

Questions and Answers

PRODUCTION PROBLEM

W. E. H.—Will some reader of MACHINERY who has had experience in producing pieces similar to the one shown in the accompanying illustration describe the machining methods employed? The pieces are to be made from steel and are cyanide hardened.



How should this Piece be machined?

PREVENTING POWER PRESS BREAKAGE

E. B. H.—In the plant where the writer is employed, production is occasionally delayed by the necessity for repairing punch presses that have been damaged or broken as a result of overloading. Is there some simple method of determining the safe ram pressures for cutting, stamping, drawing, and forming sheet metal, so that these delays may be avoided? Also will you please give the formula generally employed in calculating the pressure required in blanking sheet-metal parts?

A.—A well-known company employing a large number of punch presses recently had the allowable ram pressure of each press calculated and marked plainly on its front side with the object of preventing breakage from overloading. The maximum capacity, in tons, was painted in white figures 1 inch high on the press, and the required operating pressure was stamped on the side of each die so that there could be no excuse for overloading. The formula used by this company in calculating the allowable ram pressure is,

$$S = D^2 f$$

in which S equals the allowable ram pressure, D the shaft diameter at the journals, and f a constant for each type of press as given in the accompanying table.

TABLE OF CONSTANTS FOR CALCULATING RAM PRESSURE

Type of Press	Constant
Straight sides, geared	3.5
Straight-sided, flywheel	3.0
Straight-sided, flywheel—extra wide	2.5
Gap-sided, geared	2.5
Gap-sided, flywheel	2.0

The conditions under which the formula is to be employed are outlined as follows:

1. The maximum pressure is to be exerted near the bottom of the stroke.

2. Flywheel presses are to be operated at a speed of from 50 to 125 strokes per minute.

3. Geared presses are to be run at a speed of from 5 to 60 strokes per minute.

4. Presses that are made extra wide between the uprights and intended for long punchings are not to be used on work that gives a concentrated load at the center of the bed.

5. Unless otherwise specified, the safe ram pressure of any press having one or more cranks supported between two bearings, such as toggle drawing presses and forming presses, may be determined by the same methods as are applied to cutting presses.

6. The safe ram pressure of punching presses having an overhung crank is to be determined by the cutting press rules based on the diameter of the large bearing.

Pressure Required for Blanking

The approximate pressure, in tons, required to blank steel parts can be determined by multiplying the lengths of the cut edges or the circumference of the blank by the thickness of the material, in inches, and multiplying the product thus obtained by 30, or if the material is soft brass or copper, the result is multiplied by 20 instead of 30. Ordinarily no allowance is made for shear on the die, resistance of the stripper, friction of the punch in the die, etc. When the stripper pressure is unusually high or other conditions greatly increase the load on the press, due allowance should, of course, be made. If there is an opportunity to do so, new dies should be tested in a hydraulic or other suitable press in order to determine the actual operating pressure.

LOCATING A CENTER LINE ON A CURVED SURFACE

A. R. L.—Referring to the accompanying illustration, is there some simple method of scribing a center line C on the curved surface of the round bar D, which will be exactly half way between the two parallel lines A and B?

ANSWERED BY A. BERG, FITCHBURG, MASS.

The scribing of a line exactly equidistant from two parallel lines on a curved surface is not an easy thing to do. A method that the writer has used with success, however, is given in the following. The piece of work D is held in a chuck on a dividing head or on the centers of a milling machine. A center with a sharp point, such as indicated at E, is placed in the machine spindle, and the milling machine table adjusted so that the point of this center is on a line with the center of the dividing head spindle. The work is then revolved by means of the dividing head indexing crank until the top line A is in line with the sharp

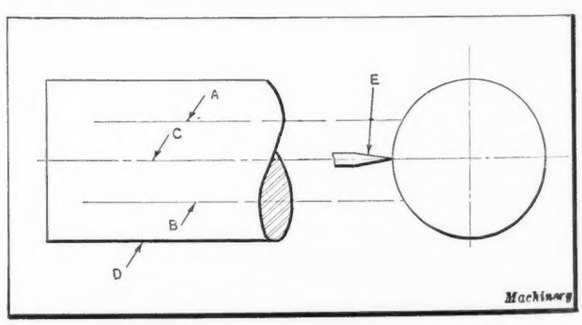


Diagram illustrating Method of locating Center Line

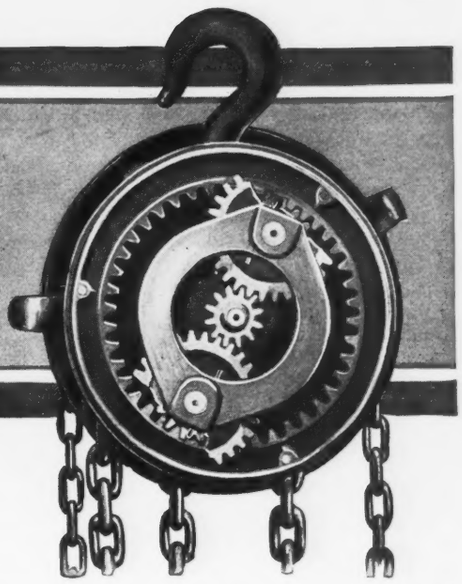
pointed center E. The position of the index-pin is then noted and the work revolved until line B is in line with the sharp pointed center. The number of turns and the number of holes the index-pin has been moved are noted and the work revolved back one-half this distance, thus locating the point of center E exactly half way between the two lines A and B. This method has proved especially useful in cases where keyways have to be located accurately after their position has been scribed from gears or pulleys.

* * *

A locomotive has the right of way and—what's vastly more important—always proves it.—*Safety Engineering.*

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Effect of Using Different Pitches for Different Pairs of Mating Gears, and Methods of Procedure
Fifth Article

AN analysis of planet wheel motion was given in the preceding article of this series, which also dealt with the natural adaptability of planetary gear mechanism as ordinarily constructed with a fixed sun wheel in the system. The possibility of designing a planetary gear mechanism to obtain an exact predetermined result was then discussed, and a method of approach and solution explained. This method consists in the simple mechanical modification of the mechanism, of giving the so-called "fixed" wheel a certain positive amount of turning instead of allowing it to stand still. By this method, intermediate reduction values may be obtained between those that result from giving the sun and planet wheels different numbers of teeth, even where the difference in numbers of teeth is only one, and where the fixed wheel remains stationary. The present article concludes the presentation of principles of planetary gearing, and future articles will cover a number of practical applications, including compound types of construction. The following notation is used:

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel; (the driver, or the follower, may be the "train arm" and not one of the toothed wheels, according to the data of a problem).

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of the fixed wheel;

D_3, D_4, etc., = diameters of pitch circles of planetary wheels;

T = number of teeth in driver, if driver is a toothed wheel;

T_1 = number of teeth in follower, if follower is a toothed wheel;

T_2 = number of teeth in the fixed wheel; and

T_3, T_4, etc., = number of teeth in the planetary wheels.

When the circular or diametral pitches of the teeth on all the gear wheels are not the same, it is necessary to make an additional construction to the diagram in solving by the graphical method; and it is advisable to do so in the geometrical method. In using the analytical method, it makes no difference whether the pitches are the same or not. In all of the problems thus far the tooth pitches on all wheels have been considered as being the same, and all problems have been given in terms of D, the diameter of the pitch circle; consequently in all drawings of the problems the mating pitch circles have always come tangent when made to scale. This means that the teeth are the same pitch on all wheels. The teeth of all the wheels in a planetary gear, however, need not be of the same circular pitch. Each pair of mating wheels may have teeth of different pitch from that of the teeth of every other pair. For example, in Fig. 18 the circular pitch of the teeth on the driver T and its planet wheel T_3 is much larger than on the fixed wheel T_2 and its planet wheel T_4.

The diameters of the pitch circles used in Fig. 18 are in the ratio of 1 to 1 for the driver and its planet wheel, and in the ratio of 2 to 1 for the fixed wheel and its planet wheel. Let it be desired to cut 16 teeth on each of the equal sized wheels T and T_3. This establishes AK as the circular pitch of the teeth, and if this pitch were used on the wheels T_4 and T_2 it would go 10 2/3 times into T_4 and 21 1/3 times into T_2, giving a fractional tooth on each wheel; therefore a new and independent circular pitch value must be assumed according to the will of the designer, for the wheels T_2 and T_4, and it may be of such a value as to go into the pitch circles of T_4 and T_2, 12 and 24 times, respectively, or 13 and 26 times, etc. In the illustration the new circular pitch has been so chosen that it goes 16 and 32 times, respectively, into pitch circles T_4 and T_2. This selection of circular pitch gives smaller teeth to the wheels T_4 and T_2 than to the wheels T_3 and T_1, but it does not change the planetary gear problem in any way, as the originally assigned ratios of the diameters of the pitch circles were not changed by the different sizes of teeth on the different pairs of wheels.

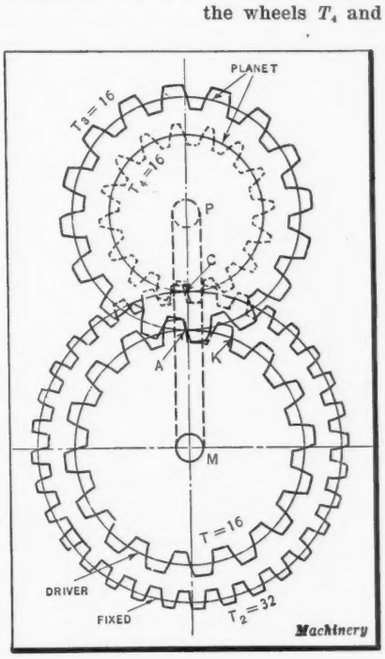


Fig. 18. Use of Different Pitches for Different Pairs of Gears in a Planetary Train

Readjustment of Pitch Circles by Graphical Method—Problem 15

Problem 15—Given $T = 30$; $T_2 = 32$; $T_3 = 36$; $T_4 = 12$. The wheels are paired as follows: T and T_3; T_2 and T_4. Find N by the graphical, geometrical, and analytical methods.

Solving Problem 15 by the graphical method, the pitch circles are first drawn *proportional* to the numbers of teeth given in the data. In drawing these circles, either pair may be taken first, as for example T_2 and T_4 which are drawn in Fig. 19, the former with 16 units for a radius, as at MC, and the latter with 6 units as a radius, as at PC. Then drawing T and T_3 to the same scale, T has a radius MU equal to 15 units, and T_3 has a radius PV equal to 18 units. These two pitch circles do not come tangent, and it follows, therefore, that the pitch on the wheels T and T_3 is not the same as on wheels T_2 and T_4. It then becomes necessary to make a readjustment.

The readjustment that is necessary to make all mating pairs of pitch circles come tangent, when the several pairs have different pitches, may be accomplished graphically or mathematically. The graphical method will be taken first: In Fig. 20, T_2 and T_4 are laid out to a scale proportional to the numbers of assigned teeth, and are tangent at C. T and T_3 are also proportional to the numbers of teeth, but they intersect as at H and J. To readjust the latter two pitch circles so as to make them come tangent, both must be reduced proportional to their numbers of teeth, and when reduced the proper amount, the sum of their radii must be equal to the distance between the sun and planet wheel centers, or MP. This reduction may be made graphically, as shown in Fig. 20. The procedure follows:

First lay off the line MK in any convenient direction; then mark the point L where the line crosses the pitch circle of T. Next lay off the distance LK equal to the radius PV of the planet wheel T_3, and draw a line from K to P. Now draw a line from L parallel to KP until it meets the center line MP at A. The radii MA and AP will then be in the ratio of 30 to 36, and the sum of the radii will be equal to the sum of the radii of T_2 and T_4. The graphical method of solution of the problem may now be applied by drawing the lines AB, BE, etc., as in an ordinary problem, and

$$N = \frac{AB}{-AF}$$

Mathematical Readjustment of Pitch Circles—Problem 15

The readjustment of the pitch circles T and T_3 in Problem 15, is made mathematically by writing two equations, substituting, and solving, as follows:

$$\frac{r}{r_3} = \frac{30}{36} \qquad \text{(a)}$$

in which r and r_3 are the radii of the readjusted circles, and

$$r + r_3 = \frac{32 + 12}{2} \qquad \text{(b)}$$

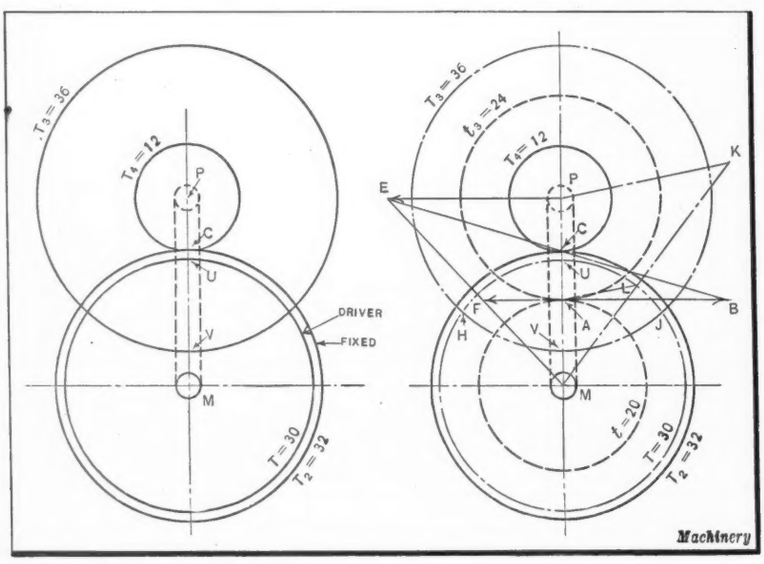


Fig. 19. Effect of laying out Pitch Circles to Scale when Different Pairs of Gears are not of the Same Pitch

Fig. 20. Readjustment of Pitch Circles by a Graphical Method (Problem 15)

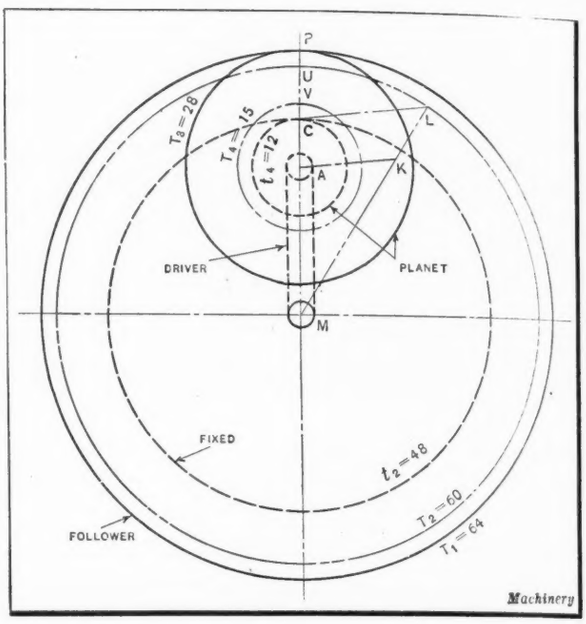


Fig. 21. Readjustment of Pitch Circles when their Point of Tangency is outside of the Planet Pin Circle—Problem 16

in which $\frac{32 + 12}{2}$ is the distance between the sun and planetary wheel centers for wheels T_2 and T_4. From Equation (a),

$$r = \frac{30 r_3}{36}$$

and substituting this value of r in Equation (b),

$$\frac{30 r_3}{36} + r_3 = \frac{32 + 12}{2}, \text{ or } r_3 = 12$$

Substituting this value in Equation (b),

$$r + 12 = 22, \text{ or } r = 10$$

Then MA, equal to r, may be laid off directly equal to 10, and PA, equal to r_3, will be laid off equal to 12. This would give the readjusted pitch circles t and t_3, and permit one to go ahead with the graphical construction, starting with AB, as explained previously.

Geometrical Method of Solution

The geometrical method of solving Problem 15 may be based, in some cases, on a freehand sketch in which the readjusted pitch circles are assumed, but it is essential that one's judgment in such a sketch should be quite accurate. A small error, with some data, might easily change the velocity lines so as to give an unintended reversal in direction. It is therefore safer to draw the sketch to scale, and to make the readjustment of the pitch circles carefully when it is desired to use the geometrical method in problems in which the circular or diametral pitch is not the same on all wheels.

In applying the mathematical solution to Problem 15, one may ordinarily visualize the problem sufficiently well with the aid of a sketch which is made roughly to scale. For example, in Fig. 19, one sees that the wheels T_2 and T_4 run together, and that wheels T and T_3 must run together, notwithstanding the lack of tangency of the respective pitch circles. With this in mind, one may set down the following general formula, in accordance with the principles used in previous problems:

$$N = 1 - \frac{T_2}{T_4} \times \frac{T_3}{T}$$

Substituting the values given in Problem 15,

$$N = 1 - \frac{32}{12} \times \frac{36}{30} = -2\ 1/5$$

In making these substitutions, it will be noted that the original tooth numbers for the wheels are used, regardless of whether the circular pitches are the same or not. The reason the original tooth numbers can be used in this analytical method of solution is because the numbers of teeth on any two mating wheels must be proportional to the circumferences, and to the diameters of the pitch circles; otherwise there would not be a whole number of teeth and spaces on each wheel. It follows, therefore, that the ratio $\frac{36}{30}$, given by the original numbers of teeth as assigned in Problem 15, must be the same as the ratio $\frac{24}{20}$ which would be the readjusted numbers when changed so as to make all four wheels of the same pitch. Either one of these ratios may then be written for $\frac{D_3}{D}$ in the general formula:

$$N = 1 - \frac{D_2}{D_4} \times \frac{D_3}{D}$$

Using the readjusted values of the diameters of the pitch circles,

$$N = 1 - \frac{32}{12} \times \frac{24}{20} = -2\ 1/5$$

This gives the same answer as was previously obtained by using directly the tooth numbers given in the data for Problem 15.

Another mathematical method of computation for the revised pitch circle diameters used in the graphical method, may be used when the diametral or circular pitches of all the wheels are known. For example, if the wheels T_2 and T_4 in Fig. 19 have a diametral pitch of 2, and if the wheels T and T_3 have a diametral pitch of 3, then

$$t = T \times \frac{\text{diam. pitch } T_2}{\text{diam. pitch } T} = 30 \times \frac{2}{3} = 20$$

Or, if the wheels T_2 and T_4 have a circular pitch of 1.5708, and wheels T and T_3 of 1.0472, then

$$t = T \times \frac{\text{circ. pitch } T}{\text{circ. pitch } T_2} = 30 \times \frac{1.0472}{1.5708} = 20$$

Similarly t_3 is found to equal 24.

Another Example of Pitch Circle Readjustment—Problem 16

Problem 16—Given $T_1 = 64$ (internal); $T_2 = 60$ (internal); $T_3 = 28$; and $T_4 = 15$ (see Fig. 21). Place wheels T_1 and T_3 together, and readjust wheels T_2 and T_4 for graphical work. Find N by the graphical and analytical methods.

The principles that apply in Problem 15 will serve in Problem 16 for those who fully understand the subject of proportioning by graphics. For those who have not had occasion to practice graphical work in this connection, a brief explanation will be made. In Fig. 20 the distance MP was divided into two parts proportional to the numbers of teeth on the wheels, and it is readily seen that it was only necessary to lay off the distance ML and LK equal to the numbers of the teeth, and then to draw the lines KP and LA thus obtaining the desired point A and also the desired proportional parts MA and AP. This means that the radial distances MU and PV were changed to MA and PA, respectively, and that these distances maintained the constant ratio represented by $\frac{MU}{PV} = \frac{MA}{PA} = \frac{T}{T_2}$.

In Problem 16, Fig. 21, it is necessary to change the radii MU and AV so that their circles will come tangent, their centers remaining the same. Since the difference between the radii of the desired circles must equal MA, it is necessary to subtract the given distance LK, which is equal to AV, from the given radius MU. This may be done on any radial line, other than a center line, as at ML. Then drawing KA first, and finally LC parallel to KA, the point C is obtained. It follows that $\frac{MU}{AV} = \frac{ML}{LK} = \frac{MC}{AC} = \frac{T_2}{T_4} = \frac{t_2}{t_4}$ and that MC and AC are the radii of the readjusted pitch circles on which the graphical and geometrical methods of solution may be made. These solutions are not given here, as they do not differ in any way from the methods and details involved in previous problems.

The following data are for the well-known Yale & Towne triplex hoisting block: $T = 12$; $T_2 = 42$ (internal); $T_3 = 29$; and $T_4 = 11$. Place wheels T_2 and T_4 together and readjust T and T_3. The answer of $N = 10\ 5/22$ is obtained by the same methods as used in the two previous problems. The same result should be obtained if the wheels T and T_3 are placed together and T_2 and T_4 are to be readjusted. This is intended as an example for practice.

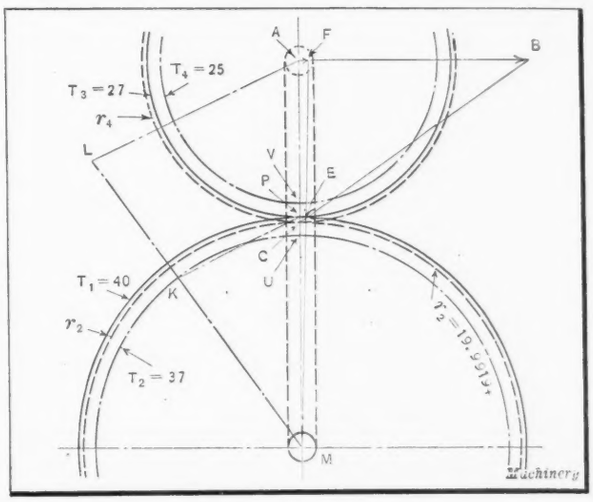


Fig. 22. Use of Sun Wheels that differ slightly in Size, in Conjunction with Planet Wheels that vary slightly in Size, in Order to obtain a Reduction of 1000 to 1—Problem 17

Problem 17—Application of Graphical Method

When the teeth on different pairs of planetary gear wheels are cut to the same pitch, they give a measure of the relative sizes of the pitch circles, for it will be recalled that the diameters of pitch circles are directly proportional to the numbers of teeth on the wheels when all are cut to the same pitch. When they are not all cut to the same pitch, the diameters of the pitch circles may be equal or very nearly equal, even though the numbers of the teeth on the wheels vary considerably. One characteristic feature of planetary gearing, as already pointed out, is that when the pitch circles are nearly equal, the ratio of reduction may be very large. It is fundamentally the diameters of the pitch circles rather than the numbers of teeth that affect the reduction of the gear. This is illustrated by the following problem which is taken from a model used in the lecture course in Mechanism at Stevens Institute of Technology.

Problem 17—$T_1 = 40$; $T_2 = 37$; $T_3 = 27$; and $T_4 = 25$ (see Fig. 22). Place wheels T_1 and T_3 together, and readjust T_2 and T_4. Find N by the graphical, geometrical, and analytical methods.

No new principles are involved in Problem 17, but the graphical construction used in the solution is of such a nature that it might seem useless unless advantage is taken of certain characteristic features. In readjusting wheels T_2 and T_4, as at LA and KE, the readjusted radii of the wheels T_2 and T_4, are found to be MC and AC, respectively; MC and AC are so very nearly equal to MP and AP, respectively, that it is not safe for one to assume that the point C is sufficiently accurate even for the geometrical method. The first operation, therefore, after making the construction at LA and KE should be to calculate mathematically for the point C, and even here it will be found

necessary to go to five decimal places to obtain approximate accuracy.

The calculation for the readjustment of wheels T_2 and T_4 (Problem 17), is made the same as in previous problems. Then r_2 is found to be 19.99194, and r_4 is 13.50806. Since the wheel T_1 has a construction radius of 20, equal to MP, and the readjusted wheel T_2 has a comparative radius of 19.99194, equal to MC, the distance PC is 0.00806. With this latter distance in mind, the construction for the graphical solution may be made in the usual way and $N = \frac{AB}{AF}$. This construction, however, unless made on an extremely large scale, such as would be impractical, could not give even a close approximation. This graphical method, however, would indicate that the follower turns in the same direction as the driver and with a greatly reduced speed.

Problem 17—Geometrical and Analytical Methods

The geometrical method may be used in Problem 17 with considerable precision even in a small-scale drawing or free-hand sketch, for, with the distance and position of PC positively known, from the computation in the preceding paragraph, the two sets of similar triangles ACB and PCE, and AMF and PME, are clearly laid down, and their proportional sides noted and calculated as in previous problems.

The analytical method is readily applied in a direct manner in Problem 17, as follows:

$$N' = 1 - \frac{T_2}{T_4} \times \frac{T_3}{T_1} = 1 - \frac{37}{25} \times \frac{27}{40} = \frac{1}{1000}; \text{ hence}$$

$$N = 1000$$

The sun wheels of this combination, which give a ratio of reduction of 1000 to 1, differ only 0.04 of 1 per cent in the pitch radii. The practical effect of such a mechanism is that the two sun wheels look exactly alike to the unpracticed eye, and so also do the planet wheels; yet the absolute reduction ratio is there. The follower moves so slowly that its turning motion cannot be observed from one instant to another, and it is only after a material period of time that its motion can be detected at all.

* * *

INTERNATIONAL STANDARDIZATION OF BOLTS AND NUTS

A first step which may eventually lead to the establishment of a world standard for bolts and nuts was taken at a conference held recently in New York under the auspices of the American Engineering Standards Committee, at which representatives of the German, Czecho-Slovakian and American national standardizing bodies were present. Soon after the War the Germans adopted national standards for bolts and nut diameters and corresponding wrench openings. This was followed by similar action in Austria, Holland, Sweden, and Switzerland, which followed the German work in the principal dimensions, with the result that nuts, wrenches, and bolt-heads are interchangeable in all these countries. Czecho-Slovakia, Hungary, Norway, Poland, and Russia are likely to adopt the same standards as the Germans.

In the United States, a large amount of work has been accomplished in the last two years by a sectional committee on bolt, nut, and rivet proportions, under the sponsorship of the American Society of Mechanical Engineers and the Society of Automotive Engineers. This committee contains more than fifty members representing about thirty national organizations, as the subject is a far-reaching one, affecting nearly every industry.

The Continental countries, in adopting their present standards, thought they were closely following American practice. Essentially what they did was to follow the so-called "United States Standard." It was natural for the Europeans to assume that this standard represents American practice, since it is found in many text-books and handbooks, under the title of "United States Standard Bolts and Nuts." According to the American representatives, however, this standard now represents less than 3 per cent of the production in this country. The bulk of the present production (except in the automobile and agricultural machinery industries) conforms to so-called "shop standards" which have heads and nuts about 1/16 inch smaller than the "United States Standard." The American sub-committee, after an extensive study and conference, has proposed a series that is still smaller by about 1/16 inch. The formulas upon which the three series, for sizes of 1 inch and below, are based are as follows:

"United States Standard" = 1.5 diameter of bolt + 1/8 inch
Present "Shop Standard" = 1.5 diameter of bolt + 1/16 inch
Proposed American Standard = 1.5 diameter of bolt

These formulas give the widths "across the flats." The conference discussed at length the advantages and disadvantages of the three systems, and the manufacturing and commercial questions involved. The Americans presented the results of extensive tests, most of which were carried out by the Bethlehem Steel Co. in which actual service conditions were closely duplicated. These show conclusively that the proposed series of nuts is in all cases, much stronger than the thread on the bolts; that is, the threads stripped off before the nuts failed. The Germans reported similar results from investigations that they had carried out.

The Americans pointed to the experience of the automobile and agricultural machinery industries as confirming the soundness of their proposed standards. In both of these, bolt and nut sizes which are practically the same as those of the proposed standard, have had long practical use. The Europeans stated that in all the Continental countries the opinion was very strong that the same wrench opening should be used for the nut and the bolt head. In many sizes, the prevailing American practice is to make the head 1/16 inch smaller than the nut, but in the proposed series, they will be the same in most sizes.

The European representatives stressed the importance of the export trade and the unsatisfactory conditions that result from competing national standards. They also emphasized the great expense and trouble that would be entailed if they were to change their standards which have now been adopted so extensively throughout Continental Europe. It was unanimously agreed that world-wide uniformity in wrench openings is so important that it would be desirable to discuss the matter in the near future in a general international conference. Each of the groups will take up the matter of such a conference with its own national standardizing body.

Other important technical points were discussed, including tolerances for round stock and the quality of the material used. It was interesting to note that while American bolt and nut manufacturers use material with a content of manganese up to 0.60 per cent and a phosphorus content not over 0.10 per cent, German manufacturers use a material containing no manganese and up to 0.40 per cent phosphorus.

* * *

EXPOSITION OF POWER AND MECHANICAL ENGINEERING

At the Third National Exposition of Power and Mechanical Engineering, known as the Power Show, which will be held at the Grand Central Palace, New York City, December 1 to 6, simultaneously with the annual meeting of the American Society of Mechanical Engineers, a number of papers will be read dealing with important developments in the various branches of power and mechanical engineering. Among the papers that will be presented is one on "Machine Tools," by Ralph E. Flanders, manager of the Jones & Lamson Machine Co., Springfield, Vt., which will be read at 8 p. m., Thursday, December 4. A motion picture program will also be given to supplement the papers read and to illustrate the important mechanical developments of the year. Among the motion pictures shown will be one entitled "The Story of Carborundum."

PRODUCTION OF MACHINE TOOLS IN 1923

(COMPILED BY THE BUREAU OF CENSUS, WASHINGTON, D. C.)

Kind and State	Number of Machines	Value
Total Value for the United States..	.....	$137,206,098
State Totals		
Ohio	.....	36,423,371
Pennsylvania	.....	12,713,907
Massachusetts	.....	12,361,593
Connecticut	.....	11,477,374
Illinois	.....	11,307,749
Rhode Island	.....	10,393,185
New York	.....	10,195,887
Michigan	.....	8,886,918
Vermont	.....	5,952,117
Wisconsin	.....	4,555,259
New Jersey	.....	3,957,631
Indiana	.....	3,294,872
All other states	.....	5,686,235
Totals for Different Types of Machine Tools		
Bending machines	616	616,443
Illinois	423	173,248
Ohio	92	149,663
All other states	101	293,532
Boring machines	803	3,577,356
Horizontal	477	1,231,584
Ohio	114	396,406
Pennsylvania	40	239,316
All other states	323	595,862
Vertical	326	2,345,772
Ohio	212	1,381,106
Pennsylvania	35	390,980
All other states	79	573,686
Broaching machines	235	347,317
Cutting-off machines	951	612,340
Rotary cutter type	299	404,467
Hacksaw type	652	207,873
Drilling machines	8,121	8,140,067
Multiple-spindle	2,081	3,431,563
Ohio	533	1,018,946
Illinois	579	655,755
Pennsylvania	100	271,115
All other states	869	1,485,747
Radial	922	2,431,268
Ohio	783	2,009,877
All other states	139	421,391
Sensitive	2,612	1,228,455
Massachusetts	977	510,596
New York	236	149,438
Ohio	376	86,064
All other states	1,023	482,357
Upright	2,506	1,048,781
Ohio	1,386	672,354
Illinois	924	210,654
All other states	196	165,773
Forging machines	120	812,877
Bolt, nut, and rivet, all states	24	100,885
Bulldozers, all states	96	711,992
Gear-cutting machines	1,107	3,506,206
Automatic, all states	453	1,235,428
Formed cutter type, all states	35	106,602
General hobbing type, all states	229	648,582
Generator planing or shaping type and other, all states	390	1,515,594
Grinding machines	19,535	7,781,682
Cylindrical	3,591	3,229,061
Plain	1,919	1,715,736
Pennsylvania	228	679,250
Massachusetts	1,036	103,440
All other states	655	933,046
Universal	1,672	1,513,325
Massachusetts	1,328	1,001,787
Pennsylvania	90	140,260
All other states	254	371,278
Surface	3,789	2,122,134
Massachusetts	3,135	1,570,187
Rhode Island	401	266,190
Connecticut	77	116,061
All other states	176	169,696
Cutter, tool and knife	571	404,549
Ohio	155	120,571
Connecticut	55	93,556
All other states	361	190,422
Internal	515	888,620
Massachusetts	364	654,750
All other states	151	233,870
Other types	11,069	1,137,318
Michigan	249	307,832
Connecticut	259	83,998
All other states	10,661	745,488
Hammers (not portable)	1,977	875,728
Steam or pneumatic, all states	1,435	585,042
Drop, all states	122	164,220
Power (belt- or motor-driven), all states	420	126,466
Lathes	11,986	$18,990,485
Engine	7,295	8,884,904
Ohio	2,545	4,573,126
Connecticut	684	1,058,893
Massachusetts	893	810,704
New York	493	440,590
Illinois	327	272,409
Pennsylvania	21	85,819
All other states	2,332	1,643,363
Bench	950	462,123
Massachusetts	356	124,937
All other states	594	337,186
Turret (including hand screw machines)	2,544	5,320,087
Ohio	1,351	1,950,129
Connecticut	318	1,213,086
Indiana	180	550,709
All other states	695	1,606,163
Other types	1,197	4,323,371
Connecticut	286	1,954,891
Ohio	290	988,671
Rhode Island	115	83,741
All other states	506	1,296,068
Planers	302	2,110,093
Ohio	163	881,434
Pennsylvania	23	171,080
All other states	116	1,057,579
Milling machines	2,906	6,047,225
Hand feed	274	93,794
Power feed	2,632	5,953,431
Plain	1,063	1,881,709
Ohio	459	820,412
All other states	604	1,061,297
Universal	453	959,967
Ohio	170	380,075
All other states	283	579,892
Vertical	328	770,541
Pennsylvania	22	159,232
Rhode Island	38	108,274
All other states	268	503,035
Lincoln type, all states	194	438,950
Planer type, all states	56	672,969
Other types	538	1,229,295
Ohio	225	166,509
All other states	313	1,062,786
Pipe-cutting and threading machines	1,958	1,002,497
Ohio	830	319,979
All other states	1,128	682,518
Portable tools	124,420	9,312,814
Drilling, electric and pneumatic	96,729	5,392,626
Ohio	37,371	2,054,237
All other states	59,358	3,338,389
Hammers, pneumatic (chipping, riveting, calking, etc.)	16,003	2,842,611
Ohio	3,065	71,856
All other states	12,938	2,770,755
Grinders, electric	10,894	812,553
Other types, all states	794	265,024
Presses	12,745	6,143,820
Hydraulic	8,633	3,821,447
Bending and forming	8,359	3,697,092
Forging, all states	274	124,355
Power, for sheet-metal work	4,112	2,322,373
Punching machines	1,390	1,119,302
Ohio	236	307,299
Pennsylvania	571	197,495
Illinois	169	161,047
All other states	414	453,461
Riveting machines	1,947	658,218
Screw machines (automatic)	2,113	4,840,739
Multiple-spindle, all states	954	2,833,781
Single-spindle, all states	1,159	2,006,958
Shapers	1,569	2,052,805
Ohio	756	668,136
Connecticut	288	480,125
Pennsylvania	7	31,460
All other states	518	873,084
Slotters	81	446,363
Pennsylvania	66	342, 293
All other states	15	104,070
Shears (power)	1,763	980,689
Ohio	148	210,549
Illinois	246	138,937
Wisconsin	657	237,378
All other states	712	393,825
Threading machines	857	1,088,910
Die type, all states	162	277,515
Milling type, all states	115	371,968
Rolling type and tapping machines, all states	580	439,427
All other machine tools	.....	22,110,484
Parts and attachments	.....	25,460,514
All other products	.....	8,571,124

The Machine-building Industries

THE result of the election has established confidence in improved business conditions to a marked degree. A considerable improvement has taken place ever since the beginning of August, but it is generally believed that this improvement will be greatly accelerated through the assurance that there will be no change in the adminstration. Even before the election there were numerous indications that the industrial conditions in the country as a whole were gradually returning to normal. Carloadings during October reached a figure never before recorded; coal production increased; the iron and steel industry continued to show moderate improvement in spite of the uncrtainties caused by the new pricing system; commercial failures were fewer; collections were comparatively easy in most fields; employment showed a small gain; the purchasing power of the public at large was indicated by the gains shown in department store sales; automobile production held its own; and textile manufacturing has shown an increase, with a gradual improvement in several other lines of manufacture. When to all these factors that were in evidence before the election is added the impetus that confidence among business men will give to industrial development, there is no doubt that a period of more active business will ensue.

Statistical Evidence of Improved Business

The statements above are borne out by statistics. The Federal Reserve Board's index of production in basic industries, adjusted to allow for seasonal variations, rose 9 per cent in September, the last month for which complete statistics are available. This was the first advance since last January. Factory employment increased 2 per cent during September, and larger working forces were employed in nearly all the industries reporting to the Federal Reserve Board. The average weekly earnings of industrial workers also increased, indicating less short-time operation. Crop conditions, as reported by the Department of Agriculture, show an improvement, and exports of wheat and cotton have been larger than for corresponding periods in recent years.

The Department of Commerce index for 51 commodities shows that the production of raw materials in September, the last month for which complete statistics are available, was 153, as compared with the average of 100 for 1919. The index figure for August was 122, and for September a year ago 131, showing a marked improvement, which, reports from individual industries indicate, has been continued during October and November. The index of manufacturing production based on 64 commodities, also relative to 1919 as 100, stood as 113 in September compared with 109 in August, and 113 in September, 1923. The fact that the production of raw materials is so materially in advance of manufacturing production indicates that the producers of raw materials either had orders in hand, or anticipated large orders and increased manufacturing activity in the near future.

Conditions in the Machine Tool Industry

The general industrial improvement is reflected in the conditions of the machine tool industry. There are definite signs of better business ahead, and some manufacturers have already concrete evidence in the form of orders actually placed. The demand for machine tool equipment depends more on business confidence than on any other element affecting business. Unless there is reasonable confidence in the future, no one is likely to invest in more manufacturing equipment. Confidence being greater now than it has been for a considerable time past, there will be greater possibilities of obtaining business for replacing obsolete machines. Practically every machine shop has a few obsolete tools, and sales efforts will be made during the coming year to replace them with new and more efficient equipment. The railroads are likely to be important customers in this respect, as the effect of the recent election has perhaps been more spectacular in regard to the railroad's position than in any other direction.

Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, states that it is very likely that we shall witness an increasing demand for machine tools for at least a year. He advises the stocking of standard saleable machines, but warns against overstocking, and particularly against the making of machine tools of obsolete design for stock. As the demand for machine tools will not reach its peak for several months to come, the best time to build for stock is right now, rather than later when the demand begins to fall off. Mr. DuBrul also advises manufacturers to put in a stock of castings while the foundries can buy iron at a low price. There is every reason to expect an advance in the price of iron and steel, even though the iron and steel industry will not be running at full capacity for some time.

Preparing for the Increasing Volume of Business

It is stated that the United States Steel Corporation plans to make an appropriation of $25,000,000 for replacements and improvement at the Carnegie Works alone, this appropriation to be spent over a period of five years. The steel corporation has always prepared for an upward turn in business by buying new equipment, and other industries would do well to follow this example, by having their machine tool and small tool equipment in readiness for the improved demand that is certain to make itself felt during 1925.

The demand for special high-production machine tool equipment fell off somewhat during the summer, but is better now, and at least one manufacturer in this field runs his plant very nearly to capacity. The foreign business in machine tools is also improving, and some machine tool builders have obtained the first orders from Belgium and Germany that they have had for the last ten years. The export market to Sweden, which has practically been dormant for four years, also shows some sign of revival.

The Small Tool Business

In the small tool business there is a slight improvement, but there is an over-capacity of manufacturing facilities in this field, much the same as in the machine tool field. This applies both to taps and dies, drills, reamers, and milling cutters. It appears that the industry has a "normal" year ahead of it, but a normal demand will not require the factories to run to capacity. It is estimated that in the tap and die field a normal demand will require 60 per cent of capacity, and in the twist drill field the manufacturers could probably produce twice as many drills as the market could consume in a fair normal business year. Prices of twist drills are less than 25 per cent above the pre-war prices, and as the quality of twist drills has been materially improved during the last ten years, the consumer actually buys drill production a great deal cheaper, expressed in dollars and cents, than he did ten years ago. In the metal saw field, demand has not been very brisk of late, but wood saw demand has been quite active, so that manufacturers engaged in both these lines have been able to keep their plants fairly well occupied. The demand for pneumatic tools shows an improvement, but the manufacturing capacity in this field greatly exceeds the demand.

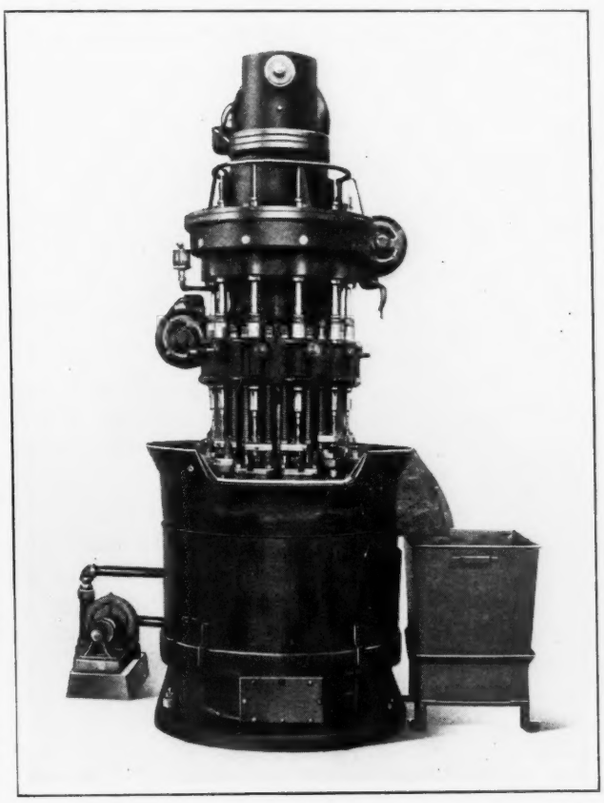
New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Langelier Continuous Drilling Machine

A TEN-SPINDLE continuous rotary drilling machine designed primarily for drilling the tapped hole in nuts used on the hub of automobile disk wheels, but which can easily be arranged to drill other parts of a similar form, has recently been brought out by the Langelier Mfg. Co., Arlington, Cranston, R. I. The hole is drilled ½ inch in diameter and to a depth of 1 inch, the production being 35 nuts per minute. These nuts are made from 0.10 per cent carbon screw stock and cold-pressed. High-speed steel drills are used for the operation, the speed being 1200 revolutions per minute, and the feed 0.0045 inch per revolution.

The machine consists essentially of a stationary heavy round post, mounted on top of a base, about which revolves a circular carrier on which the ten drill spindles, with their respective work-tables and actuating mechanisms, are supported. The weight of the carrier is taken on a large ball bearing, and there is also a ball thrust bearing at the top of the post to counteract the thrust of the drills. The nuts are located and held automatically in a fixture on the work-tables, the operator only being required to slide a blank approximately into position in each fixture as it passes by. Automatic ejection of the nuts is accomplished by means of a thin bellcrank lever on each fixture. The nuts slide down an inclined chute into a tote box.



Langelier Ten-spindle Continuous Drilling Machine

On its upper end the carrier is supported by a heavy trunnion which revolves in a bearing attached to a box type standard bolted to the rear of the bed. The carrier is driven by a one-horsepower motor through a train of reducing gears enclosed in a gear-box inside the base. This gearing drives a large ring bevel gear on the lower end of the carrier.

The drill spindles are driven by a 15-horsepower motor mounted on top of the machine. The spindles run in sleeves that can be adjusted vertically to the desired drilling positions and clamped, which enables the drills to be put in and taken out without disturbing the work-locating mechanisms. Lubrication is effected from a circular trough which is attached to the carrier at the top and revolves with it, small tubes projecting downward to the spindles. A small oil tank constantly feeds the trough to insure a steady supply of lubricant. The spindles are raised and lowered by a pinion which engages rack teeth on each spindle sleeve. Feeding of the work-tables is accomplished through cam-rolls which are fulcrumed in blocks that run on a circular-edge cam attached to the bed. This cam has a dwell which allows time for the operator to load the fixtures, and it has a total feed rise of 2¼ inches. Elevating screws provide vertical adjustment of the work-tables. The fixture on each table consists of a disk equipped with a U-block which prevents the nut from turning while being drilled. A floating fixture allows the nut to centralize itself with the drill guide bushing. Each guide bushing is carried on a plate supported between two vertical rods which are free to slide up and down in accordance with the movement imparted by the cam. The pilot rods are held in the down position by compression springs which exert a pressure that centralizes the work.

There is a device for removing the chips from the circular chip pan which surrounds the work-tables, consisting of a stationary blade which projects at an acute angle over the traveling bottom of the pan and pushes the chips into a large portable pan as fast as they accumulate. The bottom of both pans is perforated to permit the cutting lubricant to drain through. The chips are ejected through an opening at the right-hand side of the circular pan. A centrifugal pump having a capacity of 100 gallons per minute delivers a constant ½-inch stream of cutting lubricant to each drill. The pump is connected to the reservoir in the base and delivers the lubricant up through the center of the post into a rotary bulkhead. The latter has ten outlets which carry the lubricant to the individual drills.

Most of the lubricant drains from the circular pan through three spouts into a circular runway cast in the base from which it flows back into the reservoir. The delivery from the pump may be regulated by a gate valve, and there is a check valve for keeping the pump primed. The pump suction line is equipped with a strainer head made of brass wire mesh, which can be easily removed for cleaning. The lubricant pump is driven by belt from a one-horsepower motor mounted on the standard. The machine is completely surrounded by sheet-metal guards which have an opening only in front to allow the operator to feed the machine; these guards were removed when the photograph was taken. This equipment occupies a floor space of 64 by 66 inches, is 9 feet high to the top of the motor, and weighs about 6 tons.

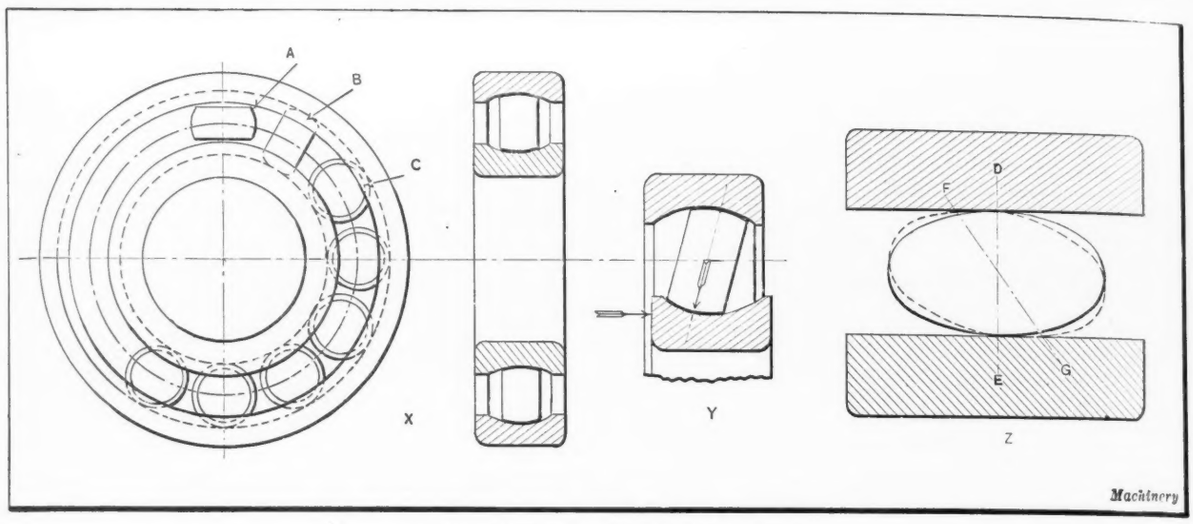


Fig. 1. Construction of NKA Disk Bearing

NKA DISK AND BALL BEARINGS

A line of Swedish radial disk bearings known as the "NKA" is being introduced on the American market by the Wollmar Engineering Corporation, 224 E. 42nd St., New York City. The construction of these bearings, for which a high load-carrying capacity is claimed, is illustrated in Fig. 1. The rolling surface of the disks is curved from side to side at a radius larger than one-half their diameter. It is to this feature, and to the fact that the cage construction permits the use of a large number of disks, that the load-carrying capacity is attributed. Another feature of these bearings is that the disks are self-guiding, the only function of the cage being to separate them.

In explaining this self-guiding feature, the disks may be considered to be cut from an ellipsoid of rotation and placed between two flat surfaces as shown at *Z*. As long as this ellipsoid rolls on the smallest great circle, the contact surfaces will be symmetrical with points *D* and *E*. However, if the disk tries to turn, for instance, to the left in an imaginary plane at right angles to the plane of the paper, and the bearing continues to rotate, thereby giving the disk a turn in the plane of the paper, the ellipsoid will appear as shown by the dotted line, with the points of contact moved to *F* and *G*. These points are not opposite each other, and so a moment will be produced which will turn the disk to the right in the plane of the paper and into its normal position.

This statical self-guiding, however, is not sufficient to produce even running of the disks, because if the bearing is subjected to radial pressure one-half the disks will be without pressure and any statical self-guiding cannot exist. However, due to the slight width of the disks, the moment of inertia about the normal axis of rotation is greater than the moment of inertia about any other axis through the center of gravity of the disks, and therefore the disks will also by dynamically self-guiding. Free rotating bodies always try to rotate about the axis with the greatest moment of inertia.

When the disk bearing is subjected to axial pressure only, the resultant force on every disk makes an angle with the axis of rotation of the bearing, and the disks take a position as at *Y* to react against the axial stresses. When the bearing is subjected to both axial and radial stresses, the different disks have different angles of reaction, the degree of which is decided by the resultant force exerted on them. The self-guiding properties of the disks have been verified by practical trials with bearings run without a cage. In assembling the disks, they are first placed between the races, as shown at *A* in view *X*, twisted into position *B*, and finally into position *C*. These disk bearings are made in all standard sizes interchangeably with ball bearings of standard sizes.

The same company is also introducing a complete line of "NKA" radial and thrust ball bearings in which the cage consists of a steel wire that is looped between every two balls to embrace a segment of each ball. This construction may be understood by reference to Fig. 2, which shows a bearing of the radial type. By using a simple cage of this design a large number of balls may be assembled between the two races so as to increase the load-carrying capacity. The races are made of chrome-nickel steel and hardened throughout. These ball bearings are also made in all standard sizes.

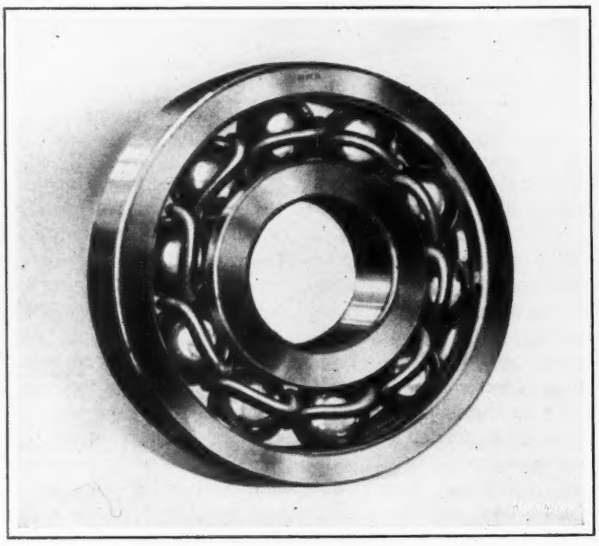
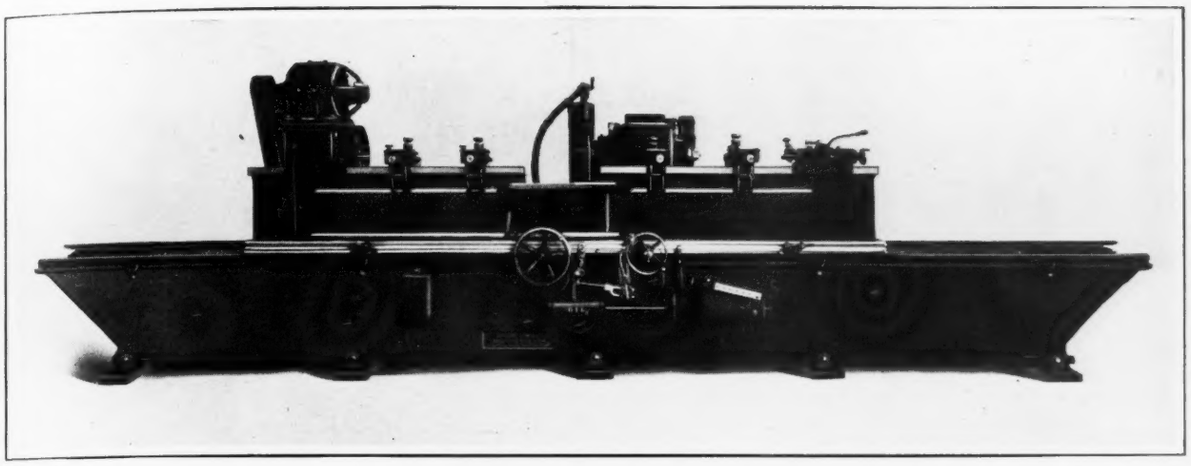


Fig. 2. NKA Ball Bearing with Spring Steel Wire Cage

NORTON LOCOMOTIVE PISTON-ROD GRINDING MACHINE

Locomotive piston-rods up to the largest sizes in use may be ground on a machine especially designed for this purpose by the Norton Co., Worcester, Mass. The rods can be ground without removing the piston, as the machine is of the gap type. Axles, valve rods, and other long cylindrical work may also be handled in this machine, as well as crankpins, bushings, and other short straight work in case a smaller grinding machine is not available. The machine is built in three lengths which have a distance between centers of 96, 120, and 144 inches, respectively, the swing over the table being 16 inches, and over the gap, 40 inches. The standard gap length is 19 inches, and it is usually located in the center of the table, but it may be 13, 25, 31, 37, or 43 inches long and located at any point to suit the customer.



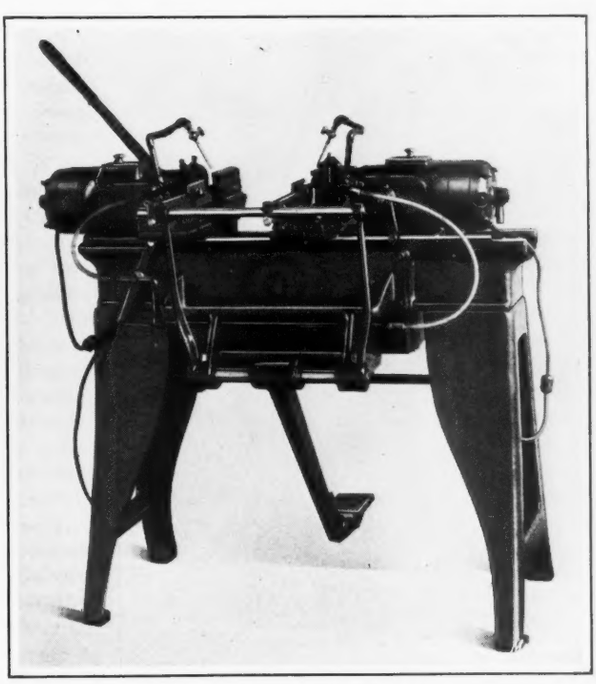
Norton Machine for grinding Locomotive Piston-rods

The drive to the work is from a two-horsepower motor mounted on the headstock, the work revolving on dead centers. The motor is of the variable-speed type, so that changes in the work speed can be obtained. The feed-screw is of large diameter and runs in a half-nut lapped to fit. These parts are generous in size so that the accuracy will be maintained. An index-gear at the front of the machine drives the feed, the wheel being advanced in increments of a quarter-thousandth inch or in multiples of that amount. There is a rapid traverse of the wheel in changing from one diameter of work to another. Grinding lubricant is delivered to the work by a centrifugal pump from a tank in the base.

PRATT & WHITNEY IMPROVED CENTERING MACHINE

An improved duplex hand centering machine recently developed by the Pratt & Whitney Co., Hartford, Conn., incorporates a new work-handling device that is operated through a foot-treadle instead of by hand. This leaves one hand of the operator free to control the drills and the other to load and unload the work. In this manner, the production possibilities of the machine have been increased and the labor of the operator lessened. In most other details, the design is similar to the hand centering machine described in November, 1922, MACHINERY.

The new work-holding device consists of two slides which carry an adjustable V-block and a movable jaw, the work being held between a vee and a flat. The movable jaw is actuated by the foot-treadle. One turn of a micrometer dial on the front of each work-slide makes an adjustment of ⅛ inch for the diameter of the work, by moving the V-block. A compensating device on the slide permits a variation of 1/16 inch either way from the nominal diameter of the work being centered. Five sets of jaws are provided to accommodate different diameters of work, and each set accommodates two diameters. In this manner a range of work from ¼ to 1½ inches in diameter is covered. A spring plunger returns the work-slide to its starting position when the pressure on the foot-treadle is released. The construction of the treadle mechanism can be clearly seen in the illustration, which shows a rear view of the machine.



Pratt & Whitney Centering Machine

As on the previous model, the heads are constructed with a built-in direct-connected motor and a two-speed gear-box. The heads receive regular centering drills, but they are easily adapted to other types of drills when the machine is arranged for special work. A single lever simultaneously feeds both drills into the opposite ends of the work. This control lever is connected to a plunger pump, so that cutting fluid is supplied to the drills only as they are fed into the work. Work from 2½ to 18 inches in length can be handled.

IMPROVEMENTS IN BUFFALO FORGE PRODUCTS

Several improvements have just been announced in machines built by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. In the Nos. ½, 1, and 2 universal iron-workers, the flywheel and pulleys have been changed from the operating side of the machine to the reverse side. This leaves the working side unobstructed and eliminates all danger to the workmen. These iron-workers have a punch, shear, and bar cutter combined. The No. ½ machine was described in October MACHINERY.

A special triple punching attachment has been designed for use with the No. ½ machine, which permits various sized holes to be punched without changing the tools. The attachment consists of a holder into which three punches are fitted, each being provided with a separate gag for individual control. The entire attachment can be easily removed by loosening four cap-screws. A special die-block is also used, and this block can be removed by loosening one nut. Any punch can be kept clear of the work by raising it and clamping it in position by means of a set-screw. The attachment has a maximum capacity for punching a 1-inch hole through ½-inch plate.

A standard one-piece hearth made of No. 12 pressed steel, 24 by 30 inches, has been adopted for the series 240-H, 340-H, 540-H, and 740-H

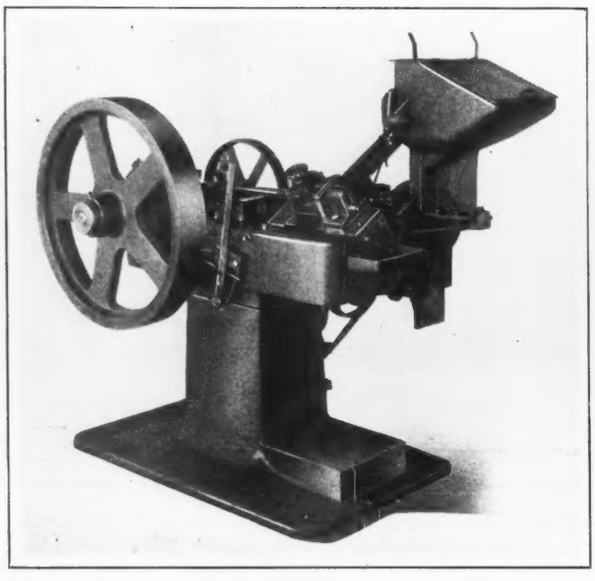


Fig. 1. Waterbury Farrel Machine for pointing Nails, Screws, etc.

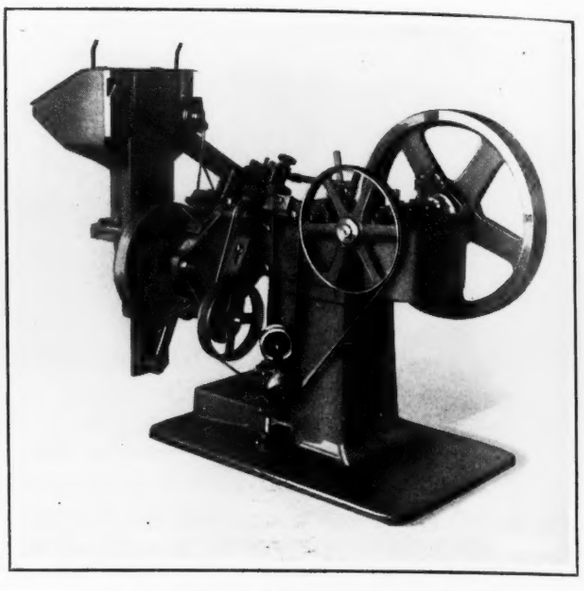


Fig. 2. Rear View of the Screw-pointing Machine

forges built by this company. This hearth takes the place of the iron casting previously supplied. It is said to practically eliminate rust, decrease the weight, lengthen the serviceability, and improve the appearance.

WATERBURY FARREL POINTING MACHINE

A machine for automatically producing conical points on wood-screw and drive-screw blanks and "pyramid" points on escutcheon pins and wire nails, etc., has been placed on the market by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. The machine is provided with a hopper feed and a chute that delivers the headed blanks into a notched dial in an index-head. Adjustments for the chute and index-head enable blanks up to 2½ inches long under the head to be pointed. The maximum capacity for diameter is ¼ inch.

The index-head is located at the same angle as the feed-chute so that the blanks pass directly to the dial. As soon as the dial has indexed 90 degrees and brought the blank into line with the dies, the die in the gate advances, partly displaces the blank from the dial, and pinches its end against the stationary die attached to the bed. Means are provided for preventing the blanks from tipping in the dial and for assuring that the points will be symmetrical and of uniform length. As soon as a blank has been pointed, it is pushed back into the dial by a spring-actuated slide; then the dial continues to index and carry the blank around until it gravitates from the dial.

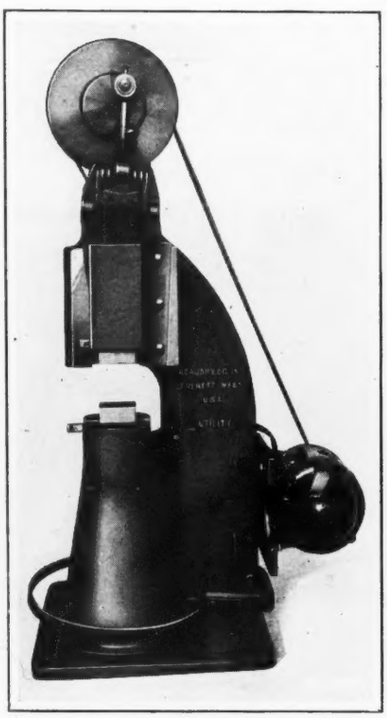
The dial is indexed by a ratchet and pawl mechanism in the index-head which is actuated by the gate. A locking device prevents the dial from moving during the pointing operation. The connection between the gate and the index-head is through a closely wound spring which is so constructed that it acts as a solid connection on the forward stroke of the gate and yields on the backward stroke if a blank becomes lodged improperly in the dial. In that case, the blank is released on the next movement of the gate, thus correcting the trouble automatically.

The dies consist simply of rectangular pieces of hardened steel, suitably formed to pinch the wire, and fastened in steel holders by clamp screws. They are made to a standard length so that it is necessary to change the dies for different diameters of wire. Four bumpers extend from the face of the die-holders, in order to prevent the dies from chipping when the moving die is in its maximum forward position. The holder for the moving die has two guide pins which are aligned with corresponding holes in the stationary die-holder to facilitate matching the dies when setting up.

The machines require a 2-horsepower motor and operate at from 100 to 160 strokes per minute, depending on the size of the point. The flywheel weighs 350 pounds, and the complete machine weighs 1375 pounds.

BEAUDRY "UTILITY" HAMMER

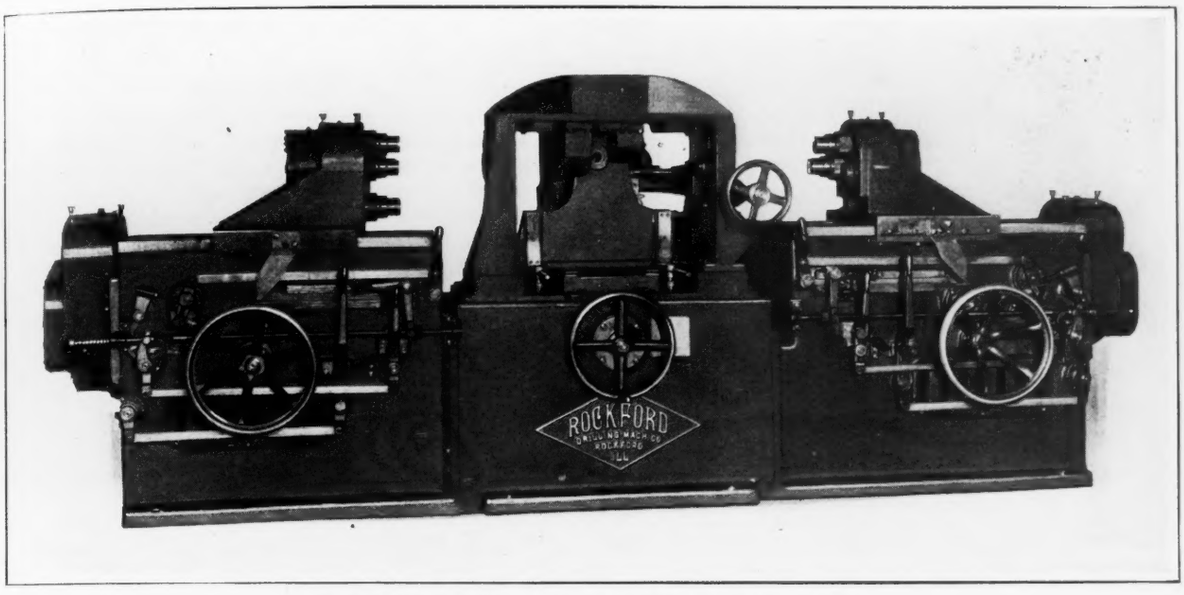
A general service hammer has recently been brought out by the Beaudry Co., Inc., Parkway, Everett, Mass., in three sizes, with ram weights of 25, 50, and 100 pounds, respectively. The small size makes up to 400 strokes per minute; the intermediate size, up to 350 strokes; and the large size, up to 300 strokes. The stroke is 6, 8, and 10 inches, respectively, and the maximum size of stock accommodated, 1½ inches square, 2 inches square, and 3 inches square.



Beaudry "Utility" Belt- or Motor-driven Hammer

The hammer may be operated by an overhead belt running at an angle or even by a crossed belt. A motor drive can also be conveniently applied without making any mechanical changes except the attaching of a motor bracket. The hammer is started, stopped, and regulated by the foot-treadle which extends around the base, a varying pressure being applied on the treadle to obtain any desired ram speed or force of blow. The treadle throws in and out a cone clutch fitted into the pulley. This clutch is self-adjusting.

The ram operates in V-guides and is adjustable on its connecting-rod to vary the height above the dies. There is an adjustable taper gib for taking up wear. The ram has external elliptical shaped tracks upon which two arms operate that are equipped with steel rollers at the lower extremities and a helical



Rockford Boring Machine of a New Line built in a Variety of Styles

spring at the top. These spring arms lift and throw the ram. Full stroke can be made when operating on various thicknesses of stock without adjustments, except for unusually heavy or special work. As the anvil is offset, long bars may be worked either way of the dies, because the work will clear the frame. The shipping weight of the different sizes from the small to the large machine is 850, 1500, and 2500 pounds.

ROCKFORD BORING MACHINES

A line of machines adapted for performing almost any kind of boring operation on a quantity production basis has recently been developed by the Rockford Drilling Machine Co., Rockford, Ill. The particular machine illustrated was built for boring an automobile cylinder block cast integral with the crankcase. The holes cored for the crankshaft, camshaft, and water-pump lines are bored from the two ends, and the oil-pump hole is bored from one side, or at an angle of 90 degrees with the others. The spindles can be arranged to suit the job on hand. The machine is furnished with a motor drive, the motor being located inside the base and connected to the drive box through a clutch, which can be disengaged to stop the machine without stopping the motor. All drive, feed, and headstock gears are made of heat-treated steel and run in oil. All control mechanisms for the drive and feed are located on the front of the machine. The heads are provided with a power rapid approach, forward feed, and rapid return, and with a hand feed in either direction. Automatic stops, which are adjustable to any point along the ways, govern each end of the traverse.

The machines of this line may be made up double-end, single-end, three-way, or with heads at right angles. There may be a stationary table with one fixture, or an indexing table with two fixtures; the latter arrangement permits almost continuous operation, as one fixture can be reloaded while an operation is being performed on work in the other fixture. In the machine illustrated the heads are fed by means of a screw and nut, but machines may be furnished with "Oil-gear" hydraulic feeds. In the latter case, all control of the rapid approach, forward feed, rapid return, and reverse feed, is obtained by manipulating but one handle. The machines of this line are built in several sizes to handle a large variety of work to be drilled or bored.

BULTMAN GAGING EQUIPMENT

An equipment designed for inspecting the specimens used in the "Izod" impact testing machine built by the F. H. Bultman Co., 10271 Berea Road, Cleveland, Ohio, has recently been placed on the market by that concern. A standard bar specimen for the "Izod" test is 10 millimeters square and has a 45-degree notch milled 2 millimeters deep near the middle. In order that the results of tests may be comparable, it is important that all specimens have the same area of metal beneath the notch, it being this area that is broken in the test. The equipment facilitates inspecting the specimens to insure that they are of uniform size at the point mentioned.

Equipment for gaging Specimens used in "Izod" Impact Testing Machine

A hardened and ground standard specimen is furnished with the machine, and from this all specimens are made. The gage is used by first placing the standard specimen on the table and then taking dial readings by bringing the V-bar down on the top of the standard and on the bottom of the groove. The specimen to be inspected is then similarly gaged, and the variations in size from the standard noted by the readings of the dial. A form cutter is also furnished for milling the notch.

REPUBLIC ELECTRIC PYROMETERS

A line of recording and indicating pyrometers with the usual thermocouple accessories, has recently been placed on the market by the Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill. In these pyrometers, the clock, having a complete time element with the usual escapement and its own main spring, performs no other function than to release the operating energy periodically through the second or power escapement. Thus no power passes through the timing escapement.

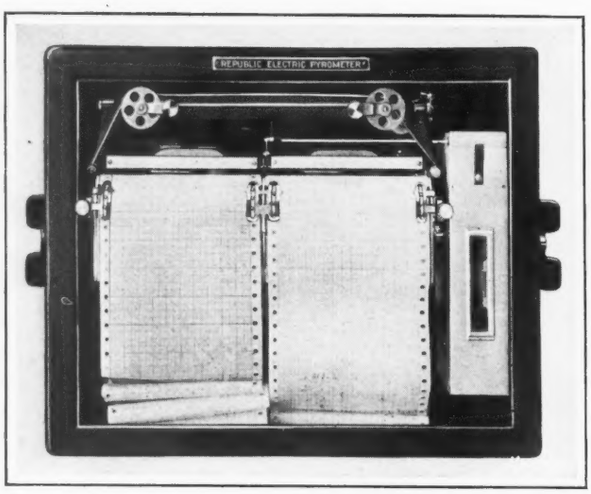


Fig. 1. Republic Duplex Recording Pyrometer

In the recording pyrometer, of which a portable type is illustrated in Fig. 1, two independent charts are used. Thus it is possible to have any combination of scale ranges desired. Six standard charts are carried in stock, the smallest range chart being 32 to 800 degrees F., and the largest, 32 to 3000 degrees F. Six-inch charts are used, the actual scale range being 5¼ inches wide. A tear groove permits extracting the record instantly without wasting any of the chart. The charts last 1200 hours.

A carbon ribbon is automatically advanced across the face of the charts, and the instrument pointer moves freely between a depressor bar and the back of this ribbon. The pointer deflects in proportion to the temperature at the hot junction of the thermo-couple. Just before the depressor bars come down, the carbon ribbon comes forward to cover the knife-edge which runs the width of the charts and is located directly beneath the depressors. When the knife-edge is covered, the depressors drop and a dot is produced on the face of the chart. The depressors then rise, the carbon ribbon drops back, and the dot just made becomes visible. A small toggle switch marked "on and off" is built into the instrument. When closed, the switch short-circuits the magnetic field and damps the movement of the pointer when in transit.

A wall-type indicating pyrometer equipped with a moisture-proof 12-point rotary selective double-pole switch is shown in Fig. 2. It will be seen that this pyrometer also has a long scale. Die-castings and bakelite moldings are employed wherever possible in the construction of all pyrometers made by this company, and the different parts are interchangeable. The four following thermo-couple elements are standard: platinum, platinum-rhodium; nickel, nickel-chromium; nickel-chromium, constantan; and iron, constantan.

Fig. 2. Indicating Pyrometer with Twelve-point Selective Switch

BESLY SPIRAL DISK AND DISK GRINDER

An abrasive disk, on the face of which two spiral ridges circle from the outside to the center, as shown in Fig. 1, has recently been placed on the market by Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., under the trade

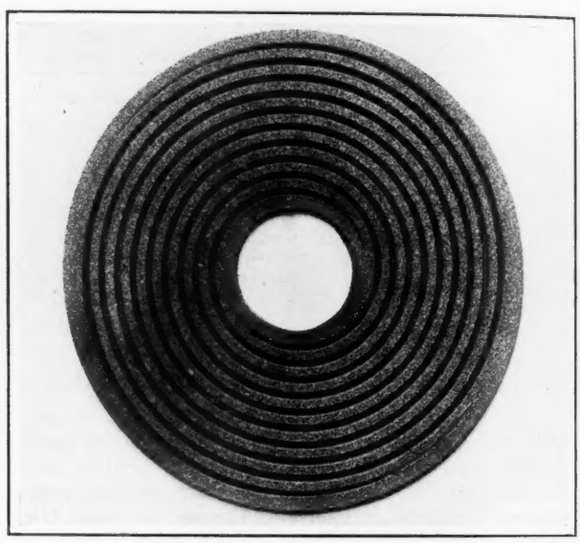


Fig. 1. Besly Spiral Abrasive Disk

name of "Titan Spiral." Between the ridges of the abrasive grain are clearance grooves which start in two places on the edge of the disk directly opposite each other so that the disk is well balanced. The grooves run practically down to the cloth, and their width, as well as the width of the ridges, can be varied to suit the work. It will be noticed that the grooves do not run entirely to the outer or inner edges, there being a full circle of abrasive at these points to keep the abrasive from breaking down. The disk is made in all grains and sizes.

Two advantages claimed for this disk are that the spiral ridges produce a shearing effect on the work, which increases the cutting quality, and that the grooves enable the grindings to escape and thus prevent the work from heating. The disk is recommended by the manufacturers for grinding large surfaces and thin work that is easily heated and warped. It can be used for wet as well as for dry grinding, provided waterproof cement is employed for attaching it to the steel disk wheel. In wet grinding, the grooves assist in carrying coolant over the work face.

A No. 108 ball-bearing disk and ring-wheel grinding machine recently brought out by this company is shown in Fig. 2. This machine is equipped with an outboard rocker shaft support on each side. These supports are separate units of a box-pattern design that holds the shafts rigidly. The two top bearings of each support are bored to receive the rocker shaft, the inner bearing extending through a cored hole in the main base and being faced on each side to receive thrust collars which hold the shaft in place and take care of the table thrust. The rocker shafts can be oscillated or clamped in their bearings.

Both table stands may be clamped to the rocker shaft at any point between the bearings. On the front face of the geared lever-feed table at the right there is a dovetail into which a vertical bar is fitted which is equipped with a rack-and-pinion elevating device. This vertical bar can also be clamped at points within certain limits. There are two studs in the upper end of the bar for attaching it to the sliding table guide. This guide can be tilted at angles up to 30 degrees. On top of the guide is a dovetail into which the table slide is fitted. The top of the table is provided with two T-slots and a keyway for attaching jigs and fixtures.

The sliding motion or feed is controlled by the hand-lever, a micrometer stop being provided for gaging the work while grinding is in progress. The table can be oscillated across the face of the disk wheel by oscillating the rocker shaft in its bearings, but it can also be used in a stationary position. The table at the left can be tilted up to 45 degrees, and is used stationary. The disk wheels are 20 inches in diameter and are fitted with the new spiral abrasive disk described at the beginning of this article. The abrasive disks are ¼ inch thick, and have a duplex spiral groove that is 3/16 inch deep, 3/16 inch wide, and has a pitch which leaves a flat abrasive ridge between the grooves that is 7/16 inch wide.

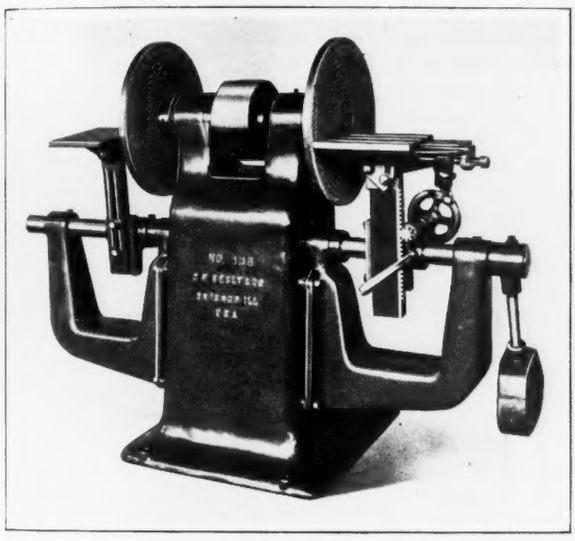
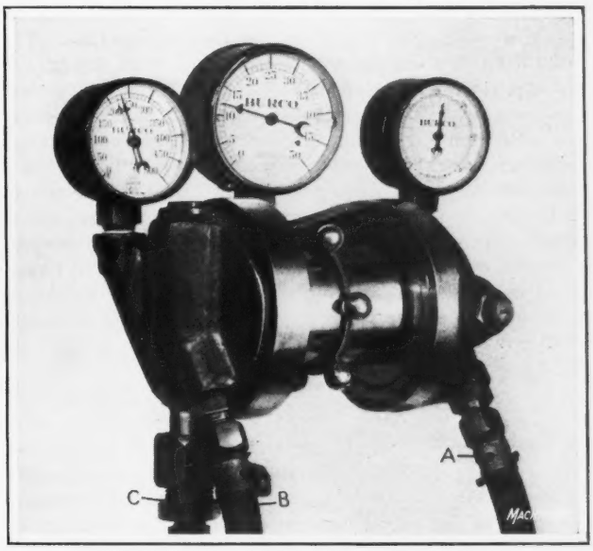


Fig. 2. Ball-bearing Equipped Disk and Ring-wheel Grinder

"BURCO" TWO-GAS REGULATOR

A safety two-gas regulator for automatically feeding both gases of oxy-acetylene equipment at an equal pressure, has recently been developed by the Burdett Mfg. Co., St. Johns Court at Fulton St., Chicago, Ill. This device is equipped with a single adjusting wheel by means of which equal pressures can be obtained in the oxygen and acetylene hose lines leading from the regulator to the torch. When turned with an upward motion, the handwheel brings an equal pressure on two controlling diaphragms by the compression of a single spring. The thrust of the handwheel is against ball bearings, so that little force is required to turn it. In the illustration, *A* indicates the oxygen torch hose; *B*, the acetylene torch hose; and *C*, the connection to the acetylene tank. The device is said to eliminate fires and explosions and to result in a more tenacious and balanced welding flame.

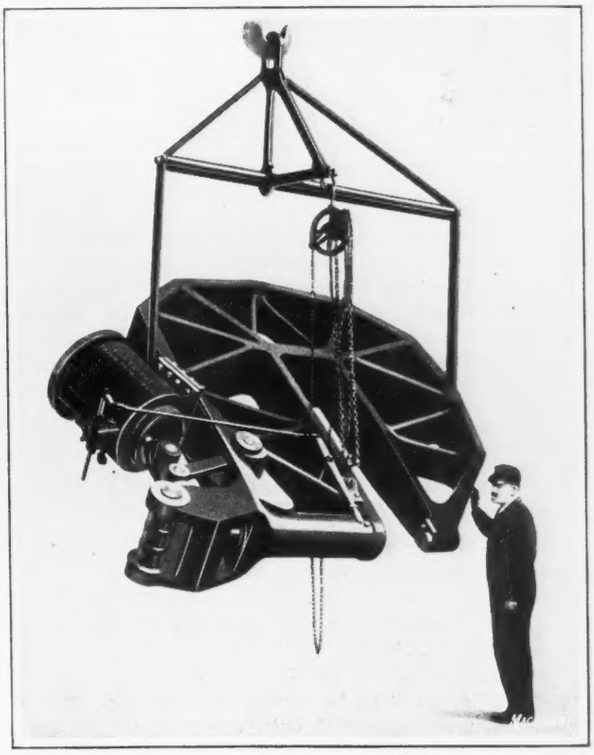
By a glance at the center gage, the operator can obtain a reading of the torch pressure for both gases. The acetylene tank pressure gage is at the left and the oxygen tank pressure at the right. The two gases flow independently until they pass the valves in the torch and reach the point of mixture either in the handle, head, or tips. It is possible to use the regulator for cutting operations when the oxygen pressure need not be greater than 40 pounds per square inch.



"Burco" Two-gas Regulator for Oxy-acetylene Equipment

HANNA RIVETER FOR LARGE WORK

A large portable riveter recently built by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill., has a reach of 75 inches and a gap of 18 inches. The cylinder is 22 inches in diameter and is capable of exerting a pressure of 150 tons on the dies at an air pressure of 100 pounds per square inch. A special bale suspension permits suspending the riveter in any position intermediate between two extreme positions. As the position of the suspension approaches the "plane of horizontal symmetry" it is easier to raise or lower the die axis by means of the bale for riveting vertical seams, than by raising or lowering the entire machine. Herein lies the utility of the special bale suspension. Incorporated in the bale is a hand-operated triplex chain



Hanna Riveter equipped with Special Suspension and Bale

block, which establishes a third point of suspension by means of which the change of position is obtained. The frame itself is a one-piece steel casting of truss design.

In this riveter is included the Hanna patented mechanism which comprises toggles that merge into a lever action. This construction develops a known and predetermined maximum uniform pressure during the last half of the piston stroke, which amounts to about the last half-inch of die travel. It is said to assure the driving of tight rivets without any adjustment of the die-screw being necessary to overcome ordinary variations in the length of rivets, thickness of plates, diameter of holes, etc. The weight of the riveting machine, including the bale, is approximately 17,150 pounds.

BENCH ROD-CUTTER

A bench device for cutting round rods of any unhardened metal from ⅛ to ⅜ inch in diameter, is manufactured by the Bench Machine Tool Co., 220 N. 13th St., Philadelphia, Pa. This device is intended to eliminate the necessity of

Bench Device for cutting off Pieces of Rod to Length

using more expensive shop equipment for cutting-off operations. The tool is equipped with two hardened alloy-steel die plates. The large leverage, together with the placing of the line of pull, make the rod-cutter easy to operate. There is an adjustable stop which may be set to cut stock to predetermined lengths, and so it is only necessary to push the material against the stop and pull the lever to cut off to any desired length.

FOOTE-BURT HIGH-DUTY DRILLING MACHINES

Two new drilling machines built in manufacturing and gear-box types are being introduced on the market by the Foote-Burt Co., Cleveland, Ohio. These No. 23 and 24 machines have a capacity for drilling up to 1¼- and 2-inch holes, respectively, through solid steel. The manufacturing type is recommended for use in a single operation where the quantity of work to be handled is large, this type of machine being arranged with only one speed and one feed. However, different gears can be furnished to give a wide range of speeds and feeds to suit any given operation. The gear-box type is furnished for miscellaneous work or for use where different sized drills are employed. Feed and speed changes are accomplished by means of sliding gears operated through levers located at the front of the machine. The gears can readily be meshed while the machine is in operation. There are three feeds ranging from 0.006 to 0.026 inch per revolution, and nine speeds of from 75 to 610 revolutions per minute. Fig. 1 shows the gear-box machine and Fig. 2 the head of the manufacturing type.

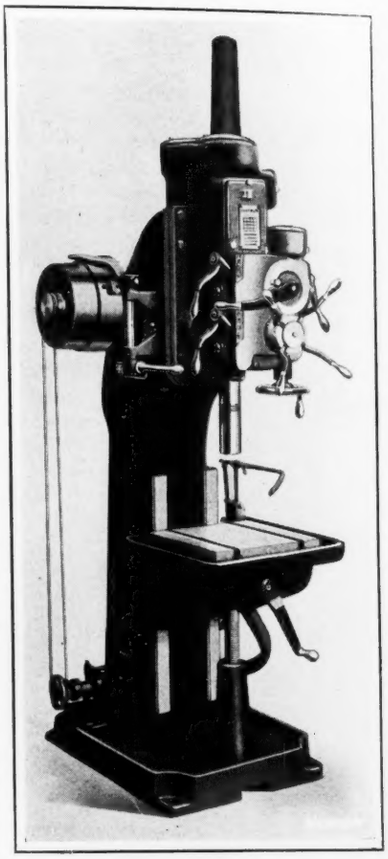


Fig. 1. Foote-Burt High-duty Drilling Machine of the Gear-box Type

The power feed is provided with an adjustable automatic disk stop. Feed is applied to the spindle sleeve through double racks cut directly on the sleeve, and pinions mounted on opposite sides. A hand feed is obtained through worm-gearing, while a quick traverse of the spindle in either direction is accomplished through a spider handwheel, located at the front of the machine.

One of the features of these machines is the construction of the head and upright. The head is of the unit type comprising the complete driving and feeding mechanism, and it is readily removable from the upright without disturbing the remainder of the machine. The upper part of the upright is a U-section in which the head is mounted. It is bolted and doweled to the front face of the upright and also bolted to rear sections. One pump-driven lubrication system supplies the complete head unit. The spindle and slow-running shafts are bronze-bushed, but all others are equipped with roller or ball bearings. The machines illustrated are

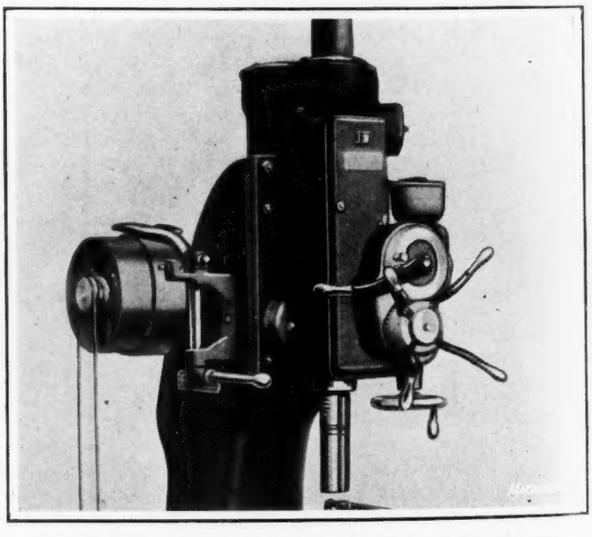


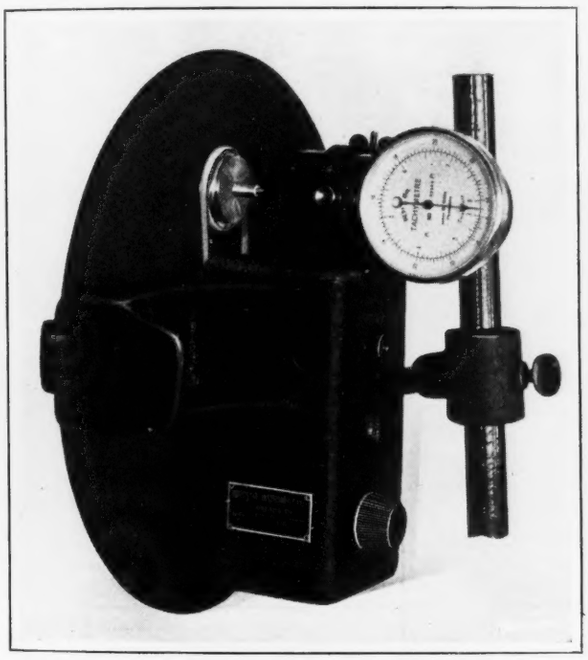
Fig. 2. Head furnished on Manufacturing Type Drilling Machine

supplied with the regular belt drive, consisting of tight and loose pulleys mounted on one side, but a direct-connected motor drive can be furnished.

The machines may be equipped with a plain or compound table, the plain table being of the knee type, gibbed to a square bearing surface on the upright and supported by the telescopic jack screw. The compound table is an extra attachment having an entirely different knee. The handwheels for controlling the longitudinal and cross adjustments of this table are both located conveniently at the front of the machine. This table is also elevated and supported by a jack-screw. The oil tank is cast directly into the base of the machine beneath the column, the base being made in the form of an oil pan for catching all drippings. The weight of the gear-box type of the No. 23 machine is about 1875 pounds, and of the manufacturing type, 1750 pounds.

ROTOSTAT ATTACHMENT

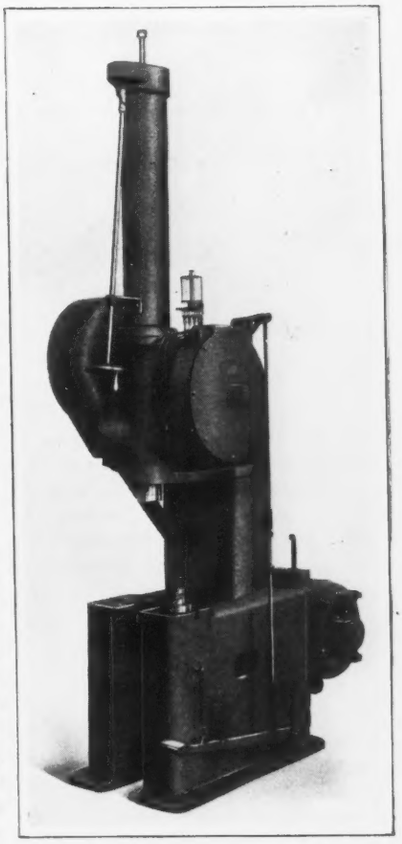
Direct speed readings of distant or inaccessible machinery and machine elements may be made by means of an attachment recently brought out for use with the "Rotostat," a form of stroboscope manufactured by the Rotostat Instrument Co., 220 N. 13th St., Philadelphia, Pa. With this instrument, which was described in September, 1923, MACHINERY, high-speed mechanisms may be made to appear as though they are moving slowly or to assume apparently stationary positions at any point of their operating cycle, when actually running at full speed. The new attachment comprises a tachometer which is mounted on the "Rotostat" and driven from it. Upon synchronizing the "Rotostat" with the observed machine, mechanism, or part, to obtain an apparently stationary object, the speed of the object may be read directly from the tachometer. Thus, speeds of overhead shafts may be quickly read from the floor of the shop, and speeds of delicate mechanisms, whose velocity would be affected by the direct application of a tachometer or speed indicator, can be accurately determined.



"Rotostat" equipped with Tachometer for determining the Speed of Inaccessible Parts

FOX POWER PRESS

A No. 40 power press having a capacity of 20 tons has been added to the line of "Superflex" presses built by the Fox Machine Co., Jackson, Mich. The 3-ton machine was described in August MACHINERY. The new larger press is equipped with a 15-horsepower motor. The base height varies with the type of fixture, the base being made low for a deep fixture and the column longer to suit, so that the under side of the head will always be at about the same height. In this press the diameter of the brake drum has been increased over past designs, so as to give a more powerful drive with a lighter pressure on the foot-treadle.



Fox Power Press

The handwheel in front is operated to raise or lower a stop that limits the upward movement of the ram. The ram can be stopped anywhere above the middle point of the stroke. A spring cushion is formed by the stop for the upper movement of the ram, the return being obtained, when the brake-band is released, through a spring inserted in the upper part of the friction drum. As in the other presses of this line, the drum is connected with planetary gears which give a flexible and yielding pressure controlled by the foot of the operator. Two nose pieces are furnished, one being nose-shaped for straightening, and the other flat for pressing in bushings. Special fixtures may be furnished for holding push-broaches. The weight of this machine is about 3640 pounds.

SOCIETE GENEVOISE PRECISION THREAD-CUTTING LATHE

A lathe large enough to produce lead-screws for machine tools has been added to the line of precision thread-cutting lathes built by the Société Genevoise d'Instruments de Physique, Geneva, Switzerland. This concern is represented in the United States by the R. Y. Ferner Co., Investment

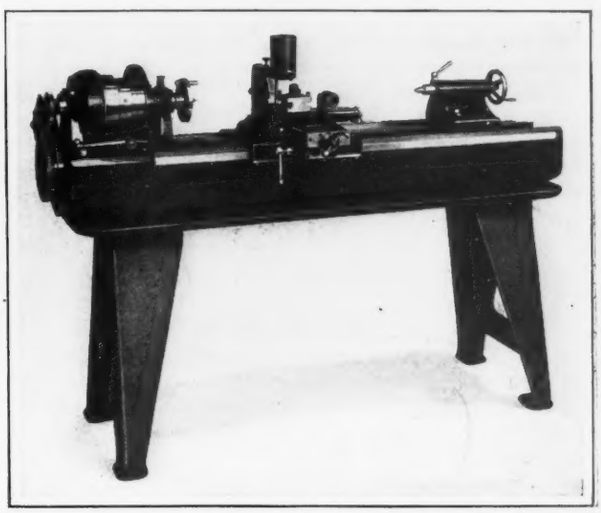


Fig. 1. Precision Lathe for cutting Lead-screws for Machine Tools

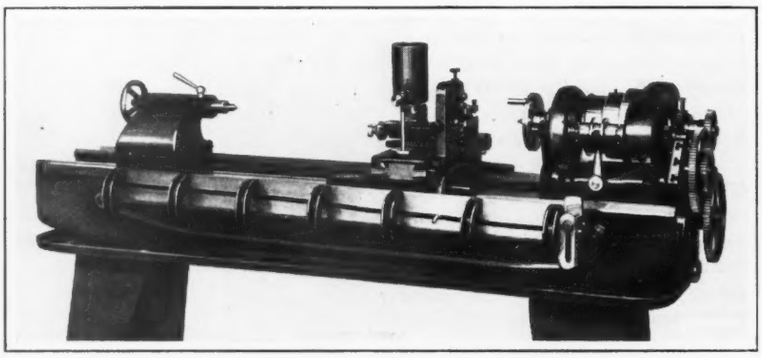


Fig. 2. Rear View of Lathe, showing the Corrector Bar that compensates for Errors in the Lead-screw and for Temperature Changes

Bldg., Washington, D. C. The new No. 6 lathe has a maximum distance between centers of 43 inches, and the height of the centers above the ways is 6 inches, the maximum diameter of work which can be threaded also being 6 inches. The lead-screw has five threads per inch. Change-gears provide for cutting thirty-six threads from 100 to 4.5 threads per inch, and twenty threads of metric pitches.

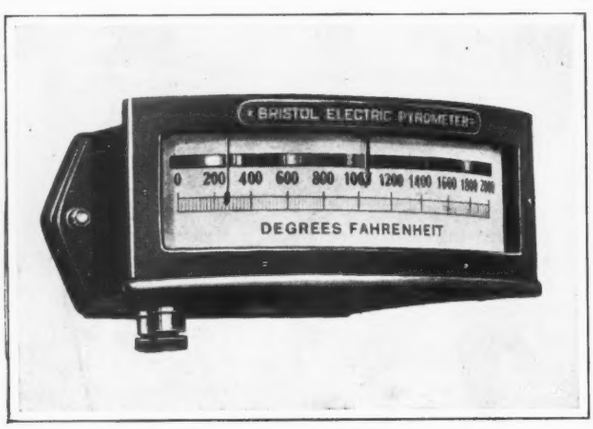
An important feature of the machine is the means employed for automatically correcting errors in the lead-screw and errors due to temperature changes. This correction device is mounted on the rear of the bed, as shown in Fig. 2, and comprises a bar which contains a long curved slot. A pin mounted on an extension from the carriage nut passes along this slot when the carriage moves longitudinally, and as the pin follows the slot contour, it advances or retards the movement of the carriage to compensate for the observed errors in the lead-screw. The frame of this corrector bar is pivoted at the left-hand end, and at the right-hand end there are graduations by means of which the bar can be set to suit any temperature. Tilting this frame out of the horizontal position, of course, gives a uniform increase or decrease to the carriage movement.

Six speeds ranging from 12 to 50 revolutions per minute are obtainable, and return speeds of four times these speeds are provided. The longitudinal slide is equipped with a holder on which is mounted a comparator tube used in checking the work in progress. The tool-slide permits the tool to be withdrawn in either direction without changing the adjustment of the holder. Graduated heads are furnished for the two slides, and a graduated circle facilitates setting the revolving tool-holder. There is also a transverse adjustment for the tailstock. In addition to cutting external threads, the machine may be used for cutting internal threads. The length is 76 inches, and the weight 900 pounds.

BRISTOL INDICATING PYROMETER

A high-resistance model 420 indicating pyrometer of the wall or switchboard type has recently been brought out by the Bristol Co., Waterbury, Conn. The instrument may be easily read because the scale is 7 inches long. To still further aid in reading, there is a combination pointer which has a broad section for distance reading and a knife-blade section for accurate close-up reading. A mirror eliminates possible errors in reading due to parallax.

A high-resistance millivoltmeter is used for the measuring element, this movement being equipped with an accurately balanced moving coil and pointer. To eliminate cold-end errors inherent in thermo-electric pyrometery, the instrument is equipped with a patented automatic internal compensator. With this compensator no correction is necessary for readings. A small screw on the outside of the case provides an easy means of zero adjustment, and a knob on top makes it possible to set the normal index spotter to the temperature desired for each individual piece of work. This pyrometer equipment can be furnished for all ranges up to 3000 degrees F.



Bristol High-resistance Indicating Pyrometer

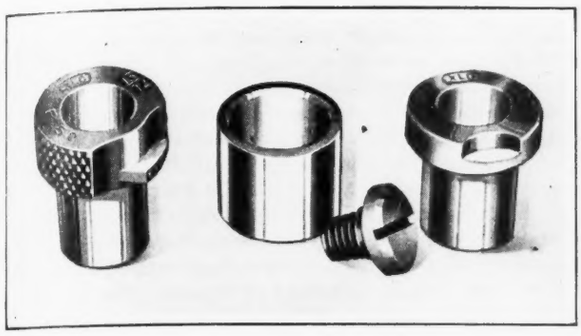
Hubbell Motor-driven Tapping Machine

HUBBELL MOTOR-DRIVEN TAPPING MACHINES

A line of motor-driven tapping machines of the design illustrated has been brought out by Harvey Hubbell, Inc., Bridgeport, Conn. These machines are operated by means of a foot-treadle which controls the motor switch and, consequently, the application of power to the spindle. The motor shaft and the spindle are provided with double-thrust ball bearings. Different types of these machines are built for drilling one hole or two or three holes simultaneously. The capacity of the machines depends on the class of work being handled, but an idea of the production will be gained from the fact that 10,000 to 40,000 holes can be tapped per day in thin brass pieces.

EX-CELL-O STANDARD DRILL BUSHINGS

A standard line of liner, plain, and slip bushings for drill jigs has recently been added to the other products made by the Ex-Cell-O Tool & Mfg. Co., 1469 E. Grand Boulevard, Detroit, Mich. These bushihgs are carried in stock for drills from No. 55 to 2 inches in diameter. The head of the slip bushings is so designed that it can easily be removed from



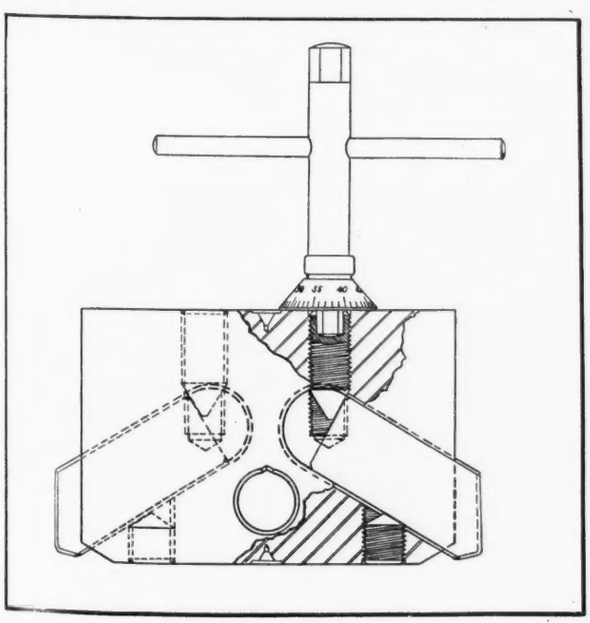
Ex-Cell-O Standard Drill Bushings

the jig, and the small-diameter heads allow a close center distance between bushings. The holes of these bushings down to 3/32 inch in diameter are ground, instead of being lapped as is common tool-room practice in finishing holes under ¼ inch in diameter. The grinding is done by employing an air-driven ball-bearing equipped grinding spindle made by this company, which is driven at 50,000 revolutions per minute.

DAVIS BORING-TOOL BLOCKS

Expanding tool-blocks such as shown in the illustration are being made in a large range of sizes by the Davis Boring Tool Co., St. Louis, Mo., for rough, semi-finish, and finish-boring operations. Blocks can be furnished for boring any hole from ¾ to 18 inches in diameter, eight groups of blocks covering the entire range. They are held rigidly for roughing and semi-finishing cuts and preferably floated for finishing cuts.

These blocks are provided with center holes to permit grinding them while held between centers. Each cutter or blade is locked in position by a hardened headless screw which comes in contact with the blade at an angle in such a way that the blade is forced back against the expanding screw and at the same time brought firmly up against the top of the blade slot in the block. This construction results in an evenly distributed bearing for the full length of the slot and hence in a rigidly held tool. The blades or cutters are evenly expanded by means of the wrench, which is graduated in thousandths of an inch to simplify, as much as possible, setting the blades to compensate for wear or to bore to any particular diameter. It takes but a few seconds to expand the blades to a given size without grinding or applying calipers. Blocks may be provided with cutters for boring into and squaring the bottom of a hole or for boring in advance of the body. The cutters are made of high-speed steel and stellite.

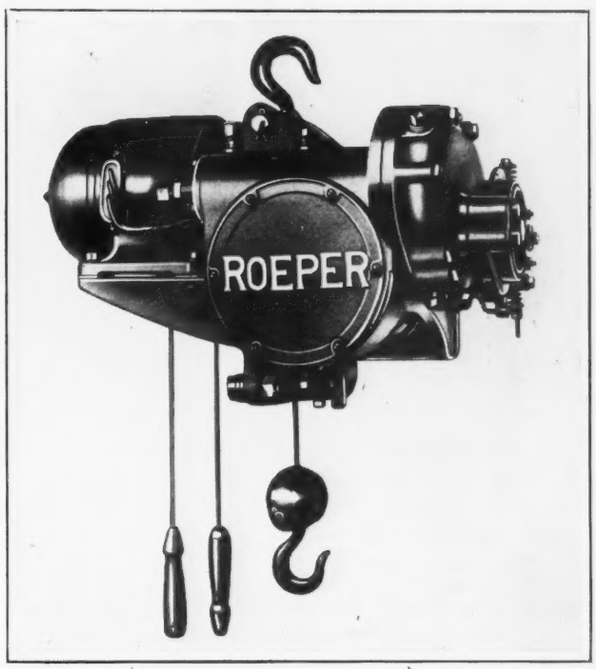


Davis Expanding Block for Boring Tools

ROEPER ELECTRIC HOIST

A small type R electric hoist has been brought out by the Roeper Crane & Hoist Works, Inc., Reading, Pa., to complete a line of electric hoists ranging from 500 to 20,000 pounds in capacity. The hoist is worm-geared, the worm being placed above the gear with a view to reducing wear and its attendant troubles. The worm-shaft is equipped with a ball and thrust bearing. The motor is mounted directly on an extension of the hoist frame, and is equipped with a jaw brake which is operated mechanically in series with the controller to bring the motor to a quick stop and prevent the load from drifting when the power is cut off.

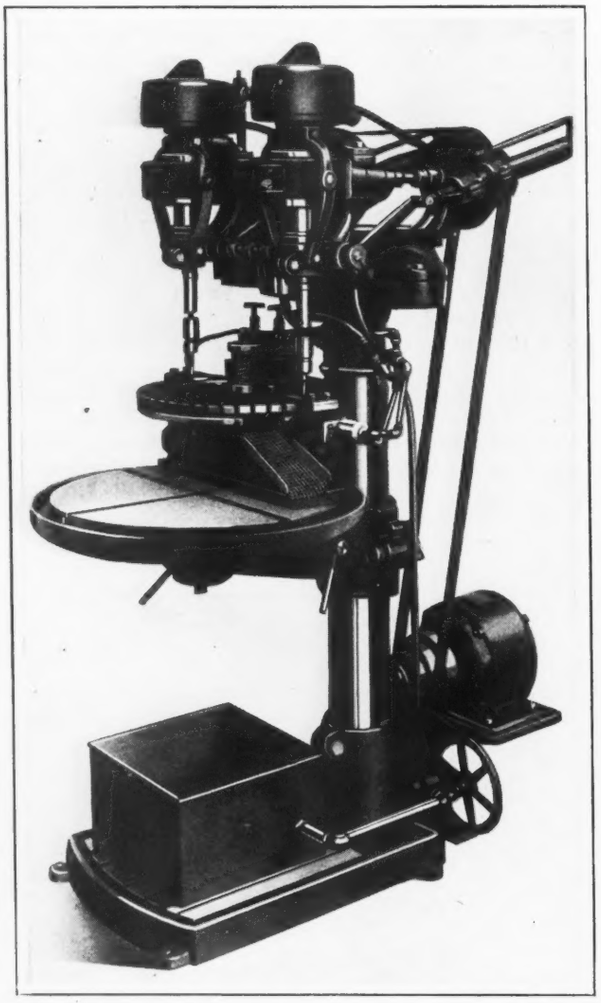
The main frame is a one-piece casting that contains all the bearings, so that shafts and other moving parts will not get out of alignment. Steel suspension plates reaching from the drum shaft to overhead suspension members relieve the casting from tension and provide a means for attaching a hook, link, clevis, or any form of special suspension. An automatic stop of the trip-lever type, which is positive in action and can be adjusted to suit any distance of hook travel, affords protection in extreme lifting and lowering. The controller is of a standard single-speed drum type. A push-button control can also be furnished, in which case the motor is equipped with a magnetic brake and an adjustable upper-and-lower limit switch. The illustration shows a hoist arranged for hook suspension, but it can also be furnished with either plain or geared trolleys.



Roeper Small-sized Electric Hoist

GATERMAN DOUBLE-SPINDLE TAPPING MACHINE

An automatic double-spindle machine has been added to the line of oscillating tapping machines built by the W. Gaterman Mfg. Co., Franklin and 15th Sts., Manitowoc, Wis. The new machine is intended for tapping large quantities of small electrical and other parts. The oscillating arrangement is operated pneumatically to eliminate tap breakage, in the same manner as the machine described in October,



Gaterman Automatic Double-spindle Tapping Machine

1923, MACHINERY. When the strain on the tap becomes greater than advisable, the tap spindle is oscillated automatically and the strain reduced.

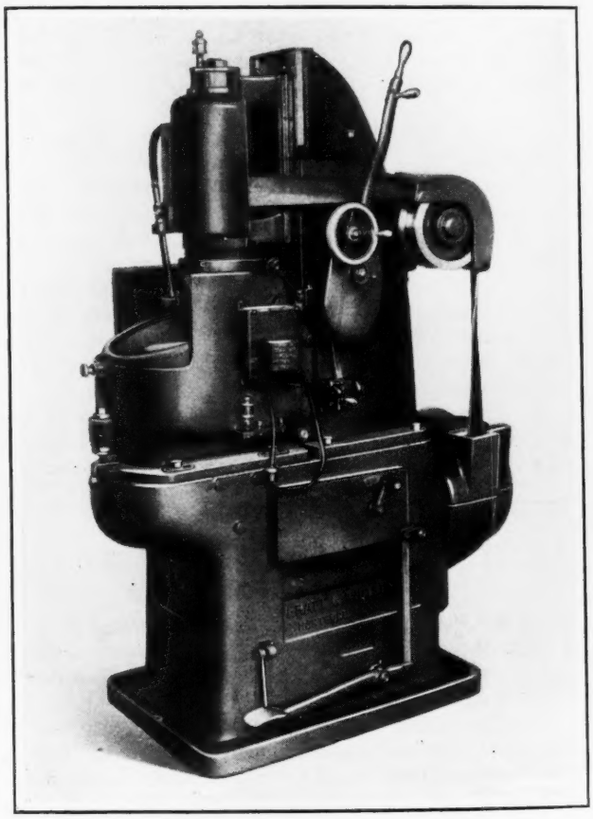
The work fixture is of a horizontal design that is automatically indexed by a small air cylinder to bring different pieces of work beneath the spindles at each stroke. If one spindle strikes a piece of work more difficult to drill than that encountered by the other, the first drill to complete the hole will simply rise and await the return of the other before making the next stroke. Similarly, if the operator should fail to load a station, the drill fed to the empty station will simply descend quickly and then return to the upper position where it will remain until the other spindle is raised. The particular jig illustrated is used in tapping bottomed holes $\frac{3}{8}$ inch in diameter with 24 threads per inch, to a depth of $\frac{5}{8}$ inch. The production is 2000 tapped holes per hour. The machine is built in two sizes, one of which taps holes from $\frac{1}{8}$ to 5/16 inch in diameter, and the other from $\frac{1}{4}$ to $\frac{3}{4}$ inch.

PRATT & WHITNEY ROTARY SURFACE GRINDER

An improved design of the 8-inch rotary surface grinder built by the Pratt & Whitney Co., Hartford, Conn., which was described in August, 1921, MACHINERY, is being placed on the market. Among the improved features may be mentioned the lengthened and improved feed-lever, ball bearings on the change-gear shaft, enlarged passages for the coolant so as to insure an ample supply, roller bearings for the counterweight chain pulley, a fine-mesh magnetic chuck with cast-iron water guards which prevent any possibility of a short circuit due to water, and an improved chuck switch. Also, the chuck is detachable without disturbing other units, the coolant pump has been improved and located in a more advantageous position, and a spring bumper has been added to the water guard. All control levers and knobs are located within easy reach of the operator.

The entire magnetic chuck mounting is hinged and provided with a screw adjustment for tilting the chuck. By means of this device and a centering plug that keeps the work central on the chuck, washers and similar parts may be ground concave or convex as desired. This attachment is especially useful in the tool-room where cutters are ground with a slight concave relief on their sides. An improved switch controls the magnetizing and demagnetizing of the chuck. The drive to the chuck contains a two-speed gear change, which is conveniently controlled by a lever, and a friction clutch controlled by a foot-lever. The latter is especially convenient, as it leaves both hands of the operator free for handling the work and feeding the wheel.

Two wheel-feed controls are provided, one being a quick vertical feed by means of a lever which is extensively used in rough-grinding operations, and the other a fine-feed for close limit work. The fine feed is obtained through a hand-wheel graduated to 0.0002 inch. Coolant is carried in a large tank within the base and pumped to the center of the wheel. Automatic control of the flow is obtained by a connection with the wheel-feed lever, the coolant starting to flow as soon as the wheel is lowered toward the work. The machine is regularly furnished with a belt drive from a countershaft, but it may also be equipped with a constant-



Pratt & Whitney Improved Rotary Surface Grinder

speed motor mounted on an adjustable base. This machine is extensively used for rough-grinding such parts as cover-plate castings, doors, guards, etc., but it is also suitable for precision work.

WILMARTH & MORMAN CUTTER AND TOOL GRINDER

A No. 99 universal grinding machine for cutters, tools, and reamers, is being introduced on the market by the Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand

Rapids, Mich. This machine may be equipped with a belt drive or with a motor drive as illustrated. A ½-horsepower motor is mounted on the main head, and a ⅛-horsepower motor on the headstock, all electrical controls being located on the knee in front of the operator. With a motor drive, no superstructure or frame is required around or above the machine, and belts do not interfere with the freedom of operation. Hence, the head or the table can be swung around a full 360 degrees. Power for driving can be conveniently taken from a light or power circuit through a connection at the rear of the machine.

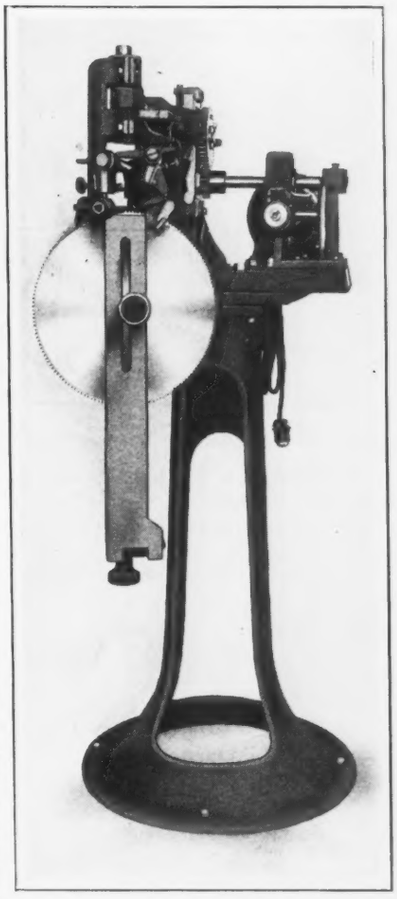
Both the belt- and motor-driven types have a patented front and rear control of the longitudinal feed. There is a micrometer adjustment for the table which can be used regardless of the angular setting of the table. The knee is supported entirely around the column, and is protected from dust and grit, as are also all working parts beneath the saddle. Sliding parts are equipped with taper gibs or adjustable take-up nuts. All attachments are interchangeable with the No. 1 machine described in April MACHINERY.

A few of the specifications are as follows: Longitudinal movement of table, 16 inches; vertical movement, 8 inches; transverse movement, 8 inches; working surface, 5½ by 32 inches; maximum swing of work on centers, 10⅜ inches; swing in universal attachment, over table, 16 inches, and over sub-table, 24 inches; speed of internal grinding attachment, 9000 and 18,000 revolutions per minute; speed of main spindle, 3000 and 6000 revolutions per minute; weight of belt-driven machine complete with all attachments, about 1225 pounds, and of motor-driven machine complete with attachments, about 1100 pounds.

Wilmarth & Morman Universal Cutter and Tool Grinder

WARDWELL CIRCULAR SAW FILER

All woodworking circular saws, whether of the rip or cross-cut type, and with or without beveled teeth, can be sharpened at a speed of 65 teeth per minute in the machine here illustrated. This machine has recently been added to the line built by the Wardwell Mfg. Co., 110-112 Hamilton Ave., Cleveland, Ohio. It is automatic in operation and may be equipped with either a belt or motor drive. The illustration shows the machine equipped with a direct-connected motor drive and mounted on a pedestal, but belt- and motor-driven styles are also made in bench designs. Teeth are sharpened uniformly as regards spacing, height, and bevel. There is an adjustment to provide for three different degrees of bevel.



Wardwell Saw Filing Machine for Cross-cut and Rip Circular Saws

In filing rip saws, any amount of hook can be obtained because the file strokes the teeth elliptically, the same as in hand work. The movement of the filing arm is positive, the arm working between adjustable bronze gibs, which insures an accurate movement of the file. The saw is automatically locked and held rigid while a tooth is being sharpened and then automatically released to allow the next tooth to be brought into position, after which the saw is locked as before. Saws up to 18 inches in diameter and with a distance up to ½ inch between tooth points can be handled.

CRESCENT V-TYPE WORK SUPPORT

A new work support consisting of two vees which cross at right angles to each other has just been brought out by the Crescent Engineering Co., 404 W. Conway St., Baltimore, Md. This support also incorporates another feature of construction on which a patent is pending, comprising two tool-steel, hardened or ground keys or pins on the bottom, which

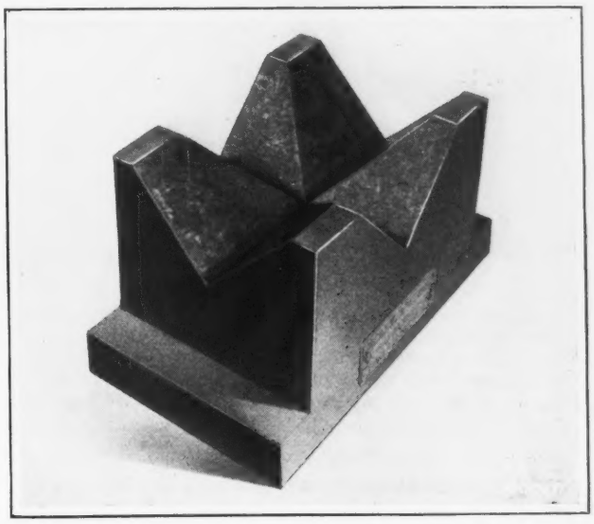


Fig. 1. Crescent V-block with Two Vees and Locating Keys

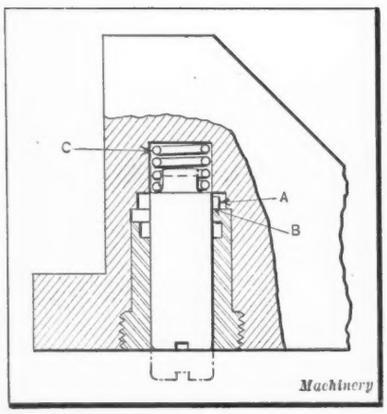


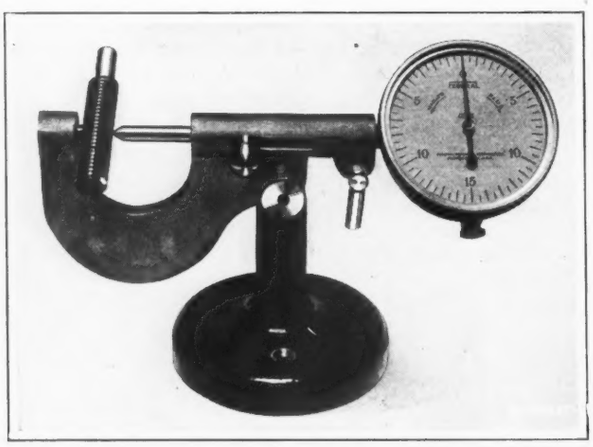
Fig. 2. Construction of the Locating Keys

may be raised into the block or extended from it. These keys may be entered into the slots of a machine table for aligning the vees with the direction in which the table travels or with the machine spindle. When the pins are raised into the block, as illustrated in Fig. 2, the support can be used anywhere as an ordinary V-block—for instance, on the table of a drilling machine or on a table used in laying out work.

The keys are raised by means of a screwdriver which engages the slot in the keys, pressure being applied against the keys as they are turned. This results in pin *A* near the upper end of the key being entered on ledge *B* of the recess in the casting. When the key is turned to move pin *A* off the ledge, the overhead spring *C* forces the key beyond the bottom of the block. On some blocks the keys are located off center to allow the edges of the block to be squared with any table or a plate machined on the edge and still have a good amount of bearing surface on the table. This construction also permits laying a shaft in the vees and clamping the block to the edge of a planer table in order to use the side head for cutting long keyways without changing clamps. The supports can also be used as parallels, the sides being accurate within 0.001 inch. They are regularly made in three sizes for accommodating round stock from ⅜ to 3 inches in diameter, but larger sizes can be furnished to meet the needs of a customer. There is a ledge on each end which facilitates clamping the block to a table.

FEDERAL PITCH-DIAMETER GAGE

A model 45 gage designed for measuring the pitch diameter of taps and screws has been brought out by the Federal Products Corporation, 15 Elbow St., Providence, R. I. The



Federal Gage for determining the Pitch Diameter of Threaded Parts

device has a range of from 0 to 2 inches, the gage being graduated to 0.0005 inch. The movement of the anvil is 0.03 inch per complete revolution of the indicator hand, and the range of the indicator itself is 0.3 inch. However, parts up to 2 inches in diameter can be accommodated because the position of the anvil can be changed in the holder. The device can be readily attached to a bench for the convenience of the user.

PRESTOMETER AND ABRASIVE BAND GRINDER

Several improvements have been incorporated in the new type of Prestometer fluid gage shown in Fig. 1, which has recently been placed on the market by the Coats Machine Tool Co., Inc., 112 W. 40th St., New York City. This fluid gage is equipped with collapsible feet by means of which the base may be tilted backward. The surface plate may be slid back and forth or sideways on the base so that it may be used evenly all over. A new design of back-stop for the

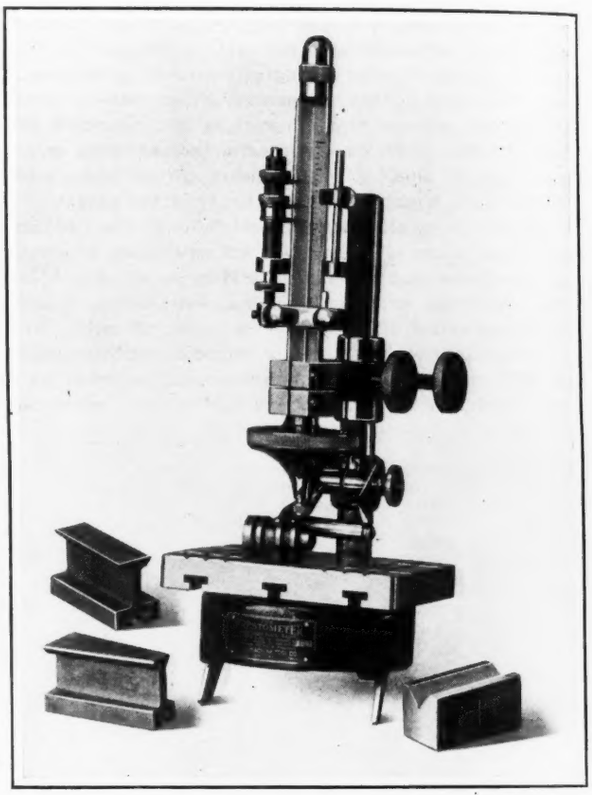


Fig. 1. Prestometer with Universal Table and Adjustable Work-stop

work is clamped on the column. This stop may be held at any angle and is reversible. Parallel and taper anvils are furnished for shoulder work and a V-block for gaging parts such as are ground on centerless machines.

The same firm is also bringing out the No. 2 abrasive band grinder shown in Fig. 2, which is of a larger size than that described in July, 1922, MACHINERY. The new grinder is provided with a belt 6¼ inches wide and 59 inches long, and the table is 8 inches wide by 20 inches long. Tension is produced on the band by means of an idler pulley. The outfit is equipped with an adjustable back-stop for the work. This grinder weighs about 150 pounds.

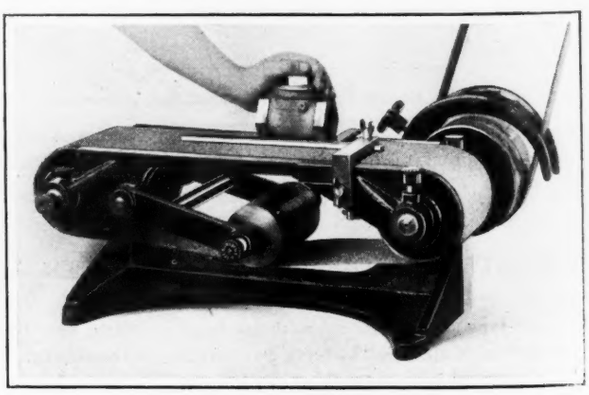
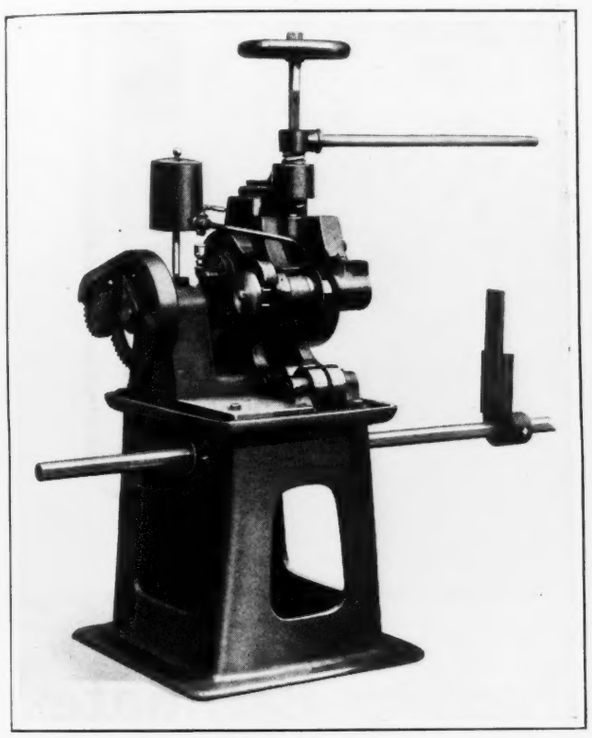


Fig. 2. Coats Abrasive Band Grinder

BIGNALL & KEELER ROLLING PIPE CUTTER

Pipe from ¼ to 4 inches in size may be cut off readily in duplicate lengths without measuring, by means of the rolling cutter here illustrated, which is equipped with a length gage. This machine is built by the Bignall & Keeler Machine Works of the N. O. Nelson Mfg. Co., Edwardsville, Ill. The pipe is severed by lowering the cutter on it. The handwheel is employed to adjust the cutter until it just clears the pipe, after which the lever is used to quickly raise and lower the cutter. Roller bearings are provided for the rolls and bronze bushings for the cutter shaft. The measuring gage may be mounted on a shaft 8 feet or more in length. This machine weighs about 750 pounds.



Bignall & Keeler Pipe Cutter equipped with Length Gage

* * *

PERSONALS

ALFRED G. NORRIS has been appointed manager of the New England office of the Strom Ball Bearing Mfg. Co., with offices at 75 Pearl St., Hartford, Conn.

A. W. WIESE, sales engineer with the Strom Ball Bearing Mfg. Co. has been transferred from the Philadelphia office to the new office at 75 Pearl St., Hartford, Conn.

N. P. FARRAR has been appointed assistant sales manager of the Pawling & Harnischfeger Co., Milwaukee, Wis. Mr. Farrar was previously district manager of the Philadelphia territory.

H. W. THOMPSON, formerly sales manager for Bardons & Oliver, Cleveland, Ohio, has been elected a vice-president of the George T. Trundle Engineering Co., of Cleveland, in charge of promotion.

T. B. H. ASKIN has been made sales manager of the Intermountain Division of the American Manganese Steel Co., Inc., Chicago Heights, Ill. Mr. Askin's headquarters will be at the Denver office.

H. L. MODE has been appointed sales representative in the eastern territory for the Pawling & Harnischfeger Co., Milwaukee, Wis. Mr. Mode will make his headquarters in New York and Philadelphia.

H. E. BYER has been appointed manager of condenser and vacuum pump sales for the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. Mr. Byer's headquarters will be at the New York office.

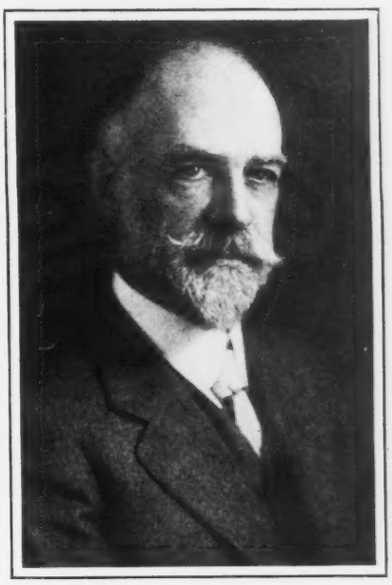
MAURICE OWENS, formerly with the Syracuse Supply Co. and with the Continental Can Co. in its mechanical department, has become sales engineer of Crane-Schiefer-Owens, Inc., Buffalo, N. Y. He will be associated with Joseph F. Owens, manager of the Syracuse office.

GEORGE L. MARKLAND, JR., chairman of the Board of Directors of the Philadelphia Gear Works, Philadelphia, Pa., and president of the American Gear Manufacturers' Association, has been elected mayor of Stone Harbor, N. J., where he has resided for the last eight years.

WILLIAM ROBERTS, consulting production engineer, 457 Main St., Springfield, Mass., will leave on January 14 for Australia and New Zealand, for the purpose of making an industrial survey for some of his clients as to the future possibilities in the machinery line in those countries.

G. E. EMMONS, vice-president in charge of manufacturing of the General Electric Co., Schenectady, N. Y., who has been in continuous service with this company and its predecessors for nearly forty years, has resigned his position and will leave Schenectady early in December for Pasadena, Cal., where he will make his home.

DR. WILLIAM F. DURAND, professor of mechanical engineering at Stanford University, will be president of the American Society of Mechanical Engineers for the coming year. Dr. Durand was born in Bethany, Conn., in 1859, and graduated in 1880 from the United States Naval Academy. For the next seven years he served in the Engineers Corps in the Naval service, but resigned in 1887 to take up teaching as a profession, first at the Michigan State Agricultural College, where he was professor of mechanical engineering until 1891, and then at Cornell University where he was professor of marine engineering until 1904. In that year he went to Stanford University, where he has been professor of mechanical engineering until he retired from active service last June.



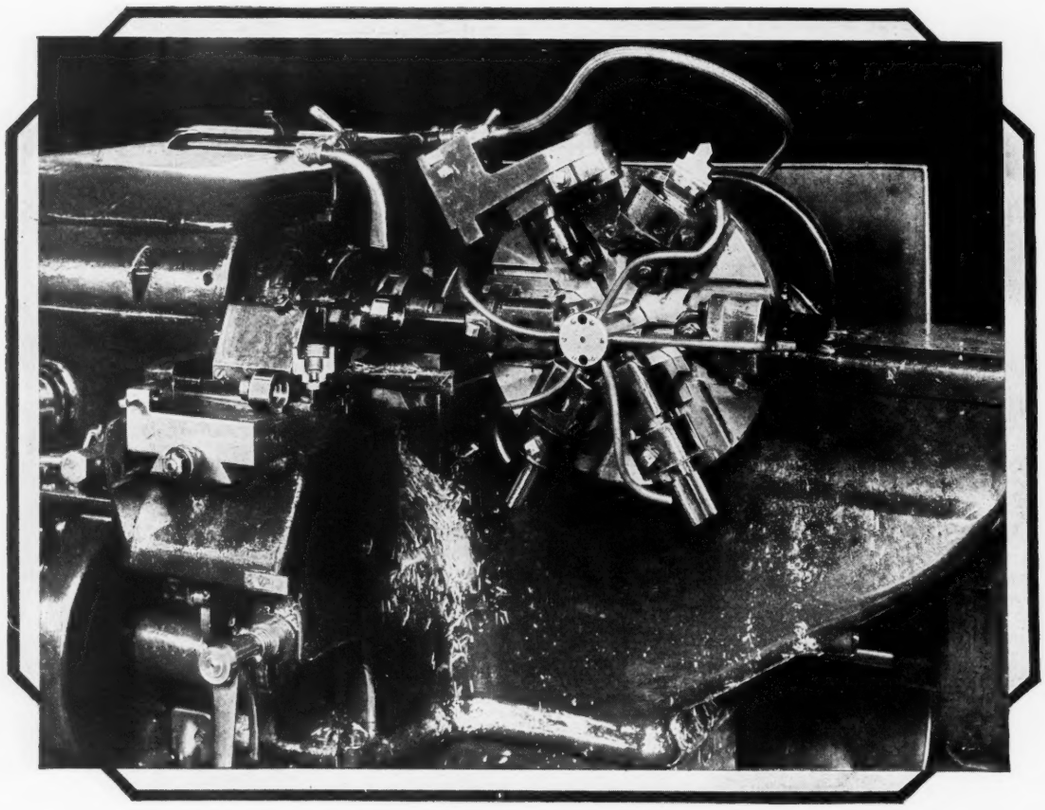
During the war Dr. Durand rendered valuable service to the country. In 1917 he was in Washington as chairman of the National Advisory Committee for Aeronautics, and vice-chairman of the National Research Council Committee on Engineering. The following year he spent in Paris as scientific attaché to the United States Embassy.

Dr. Durand is also known as an inventor. He has developed a three-point caliper for determining true circular contours, and a radial planimeter for averaging ordinates in polar diagrams. He is the author of three books, "Resistance and Propulsion of Ships." "Practical Marine Engineering," and "Hydraulics of Pipe Lines." He has been a member of the American Society of Mechanical Engineers since 1883 and was a vice-president from 1911 to 1913. He is also a member of the American Institute of Electrical Engineers, American Society of Naval Architects and Marine Engineers, and American Society of Naval Engineers.

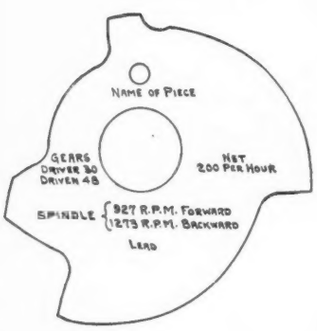
OBITUARIES

FREDERICK J. COOLEY, vice-president and manager of the Windsor Foundry Corporation, Windsor, Vt., died suddenly at the Mary Hitchcock Hospital in Hanover, N. H., on November 1. Mr. Cooley was born on May 14, 1876, in Waterbury, Vt. In 1918 he and his brother organized the Windsor Foundry Corporation for the purpose of supplying gray iron castings to the machine tool builders of that vicinity.

A. S. DAVIS, formerly president of the Seneca Falls Mfg. Co., Seneca Falls, N. Y. (now the Seneca Falls Machine Co.), died suddenly at the Geneva City Hospital in Seneca Falls, following an operation. Mr. Davis had disposed of his interest in the company in 1917.



They Maintain Production Estimates



The exact production for any job can be noted by merely glancing at the figures stamped on the cam. These cams are inexpensive to make, simple to lay out and cut, and easy to set-up in machines. They feed the tools uniformly, producing smooth finished surfaces and highly accurate work.

That is the big advantage of the disc cams used to control the feed of tools on Brown & Sharpe Automatic Screw Machines.

These cams are easily made of sheet stock for each job, and being non-adjustable guarantee the estimated production at all times. Exact duplication of previous work can be easily secured, for the entire record of the job can be stamped on the cams.

There is no guess work to determine the proper feeds and speeds. Each operation is accurately computed in advance and speeds and feeds established which give the fastest possible production.

Send us samples or blueprints of your work and secure production figures. Our Automatic Screw Machines handle work to 2″ in diameter.

Send for catalog No. 23 G.

BROWN &

Accurate Set-ups can be Made Quickly with the Right Tools

Do you supply your men with the right tools for setting-up screw machine jobs?

Many manufacturers do.

They have found that it pays to use Brown & Sharpe tools for this purpose. With the help of these tools, your men can change set-ups with greater speed and accuracy. Brown & Sharpe tools help boost production by cutting to a minimum the non-productive time consumed in changing set-ups.

Below, several pages from our Small Tool Catalog show a few of these indispensable tools. Check them over and see how they could help on your work.

Then write for a copy of Small Tool Catalog No. 29—it gives the details.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

Each tool in this catalog is made with the care and accuracy for which Brown & Sharpe has long been noted.

SHARPE

Small Tool Catalog No. 29 lists the above tools and besides contains full details about 2000 others—the best tools you can buy.

TRADE NOTES

ROCHESTER STAMPING CO., Rochester, N. Y., has been succeeded by the ROBESON ROCHESTER CORPORATION.

GIBB INSTRUMENT CO., Bay City, Mich., manufacturer of electric welding machines and electric heating machines, has broken ground for a new modern plant.

FOOTE BROS. GEAR & MACHINE CO., 232-242 N. Curtis St., Chicago, Ill., is erecting an addition to its plant with an entrance on Lake St. The new building is to be used for shipping, receiving, and raw material storage.

ENTERPRISE ENGINE CO., of San Francisco, Cal., and the WESTERN MACHINERY CO., of Los Angeles, have merged forces. This merger brings together two of the largest builders of internal combustion engines on the Pacific Coast.

WHITING CORPORATION, Harvey, Ill., has opened a district sales office at 997 Ellicott Square Bldg., Buffalo, N. Y., to succeed the agency formerly held by George F. Crivel & Co., of Buffalo. W. R. Hans will be in charge of the new office.

KILBORN & BISHOP CO., New Haven, Conn., announces a consolidation with the BAY STATE FORGE CO., Springfield, Mass. The consolidated business will be conducted at New Haven, Conn., under the name of the Kilborn & Bishop Co.

ROCKFORD MILLING MACHINE CO., Rockford, Ill., has appointed the H. A. Smith Machinery Co., 501 E. Water St., Syracuse, N. Y., exclusive representative in the Syracuse territory for the sale of Rockford millers and Sundstrand lathes.

CARPENTER STEEL CO., Reading, Pa., has opened an office and warehouse at 633 Fulton St., Indianapolis, Ind., where a complete stock of high-speed steel, carbon tool steel, and drill rods will be carried. H. J. Joyce, Jr., has charge of the office.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., has removed its New York service station to larger quarters at 321 W. 54th St. P. K. Winter continues in charge as service manager. The New York district sales office will remain at 50 Church St.

ISBECQUE, TODD & CIE, machinery dealers, have transferred their offices and showrooms to their new building at 25-27 Boulevard Emile, Bockstael, Brussels, Belgium. The building is of reinforced concrete and contains 22,000 square feet of floor space.

UNITED AMERICAN METALS CORPORATION, 196 Diamond St., Brooklyn, N. Y., is distributing to users of babbitt, a paperweight in the form of a miniature ingot of manganese babbitt. The design of the ingot is typical of all the ingots into which Syracuse babbitts are cast.

CRESCENT TRUCK CO., Lebanon, Pa., has appointed Edward C. Bywater, 1997 Central Ave., Cincinnati, Ohio, general sales agent for Crescent products throughout the state of Ohio. He will handle the complete line of Crescent electrical industrial trucks, tractors, and trailers.

JONES MACHINE TOOL CO., Cincinnati, Ohio, has moved its warehouse from the old location at 435 E. Pearl St. to larger quarters at 528-530 E. Front St. In the new location, the warehouse and office will be under one roof, and the enlarged quarters provide 100 per cent more storage space.

SHERRITT & STOER CO., INC., Philadelphia, Pa., has changed its name to STOER MACHINERY CO., INC. The company will continue to be located at 2006 Market St., Philadelphia. The personnel remains the same as before, with C. H. Stoer president, and C. R. Weber treasurer. W. C. Chapman will continue to serve as sales manager.

WHITE MFG. CO., manufacturer of casehardened brake-pins and bushings for railway trucks and other railway car parts, has moved from Goshen, Ind., into its new factory at Elkhart, Ind. The new factory is constructed entirely of brick, steel, and cement, and is nearly twice the size of the previous factory, which was damaged by fire some time ago.

BROWN & SHARPE MFG. CO., Providence, R. I., announces that at a recent meeting of the stockholders the following officers were elected: Vice-presidents, William A. Viall, Henry Buker, and Paul C. DeWolf; secretary, John A. Cave; assistant secretaries, John Sharpe Chafee and Richmond Viall. Henry D. Sharpe continues to hold the office of president and treasurer.

ROOT CO., Bristol, Conn., announces that Simon Zinn, Inc., New York City, has made arrangements with the company to take over the manufacture of the brass and other boxes formerly made by Simon Zinn. The equipment of the Zinn corporation will be moved gradually to Bristol, and on January 1 the company will begin operations from the Root plant. A selling organization will be maintained in New York.

AIR REDUCTION SALES CO., 342 Madison Ave., New York City, announces that in line with the engineering assistance rendered to "Airco" customers through its industrial engineering department, a special class was organized on November 17 for foremen, superintendents, and other executives at the Airco-Davis-Bournonville Welding Institute in Jersey City. Instruction will be given in the theory and practice of the oxy-acetylene process and the use, application, and plant distribution of industrial gases.

JOSEPH T. RYERSON & SON, INC., 16th and Rockwell Sts., Chicago, Ill., announce that the stockholders of the company have purchased a substantial interest in the Reed-Smith Co., at 19th and South Canal Sts., Milwaukee, Wis., a steel warehousing company. The latter company has a large line of finished steel products in stock, and facilities for quick shipment. Under the new plan the officers of the Reed-Smith Co. are: President, D. M. Ryerson; vice-president and general manager, George W. Smith; treasurer, E. L. Hartig; and secretary, Carl Gallauer.

FITCHBURG MACHINE WORKS has changed its name to the Seneca Falls Machine Co. Last February the company purchased the plant and business of the Seneca Falls Mfg. Co., Seneca Falls, N. Y., builder of the "Star" engine lathe and the "Short-Cut" production lathe, and has since been operating the plant as a separate unit. However, it has now been decided to move the entire plant of the Fitchburg Machine Works to Seneca Falls, where additional floor space and increased facilities are available. This move combines two of the oldest concerns in the machine tool industry. The Fitchburg Machine Works, which specialized in building production machinery, the principal machine being the "Lo-swing" lathe, was established in 1864, and the Seneca Falls Mfg. Co. in 1879. The officers of the Seneca Falls Machine Co. are Marcus A. Coolidge, president and treasurer; Edwin R. Smith, vice-president and general manager; and John A. Fyfe, secretary.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1924,

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the state and county aforesaid, personally appeared Edgar A. Becker, who, having been duly sworn according to law, deposes and says that he is the treasurer of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, and Robert B. Luchars, Vice-president, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press; Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Matthew J. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

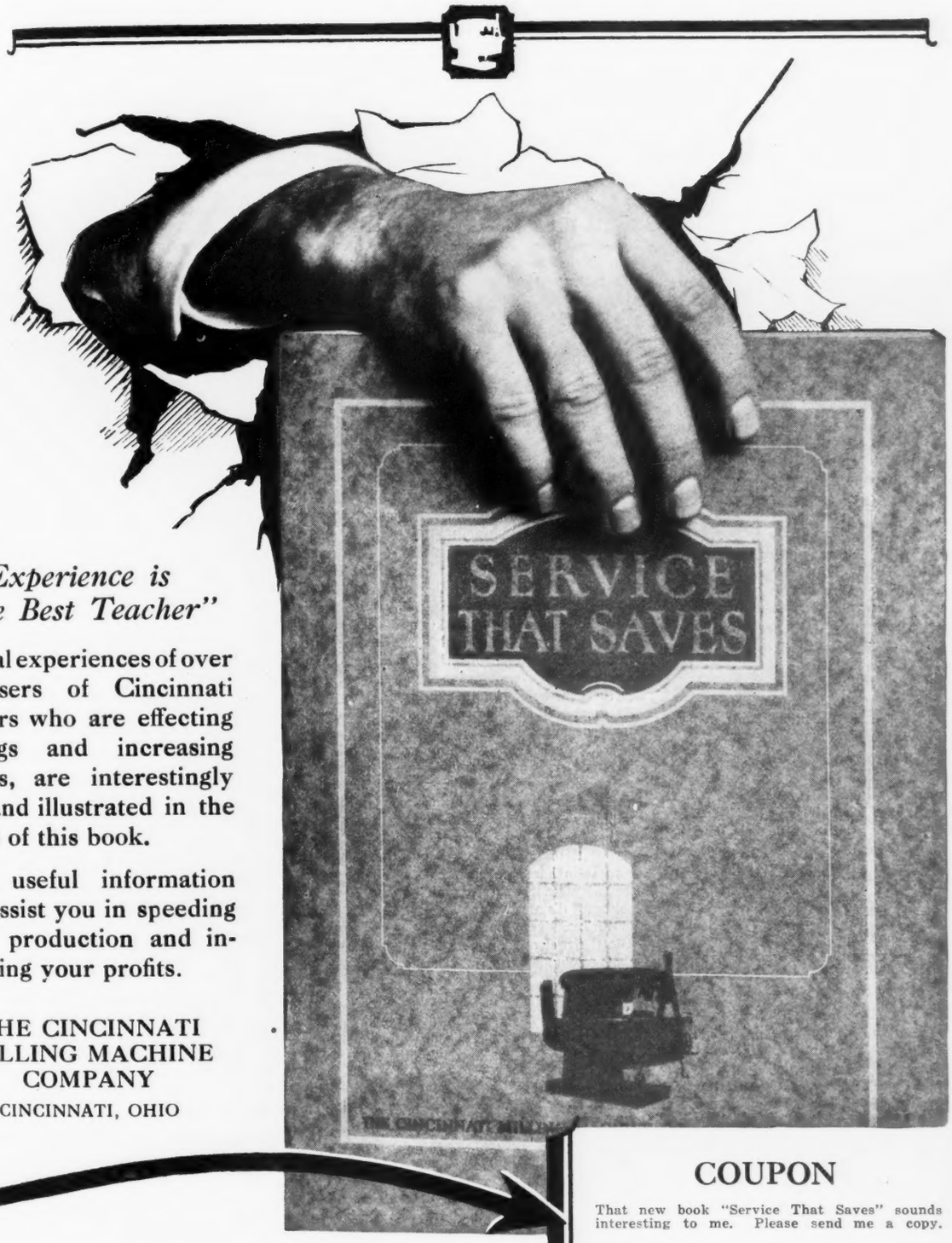
3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

EDGAR A. BECKER, Treasurer

Sworn to and subscribed before me this 17th day of September, 1924

CHARLES P. ABEL,
(SEAL) Notary Public, Kings County No. 187
Kings Register No. 5052
New York County No. 125 New York Register No. 5134
(My commission expires March 30, 1925.)



"Experience is the Best Teacher"

Actual experiences of over 50 users of Cincinnati Millers who are effecting savings and increasing profits, are interestingly told and illustrated in the pages of this book.

This useful information will assist you in speeding your production and increasing your profits.

THE CINCINNATI MILLING MACHINE COMPANY
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COUPON

That new book "Service That Saves" sounds interesting to me. Please send me a copy.

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M-1

COMING EVENTS

DECEMBER 1-4—Forty-fifth annual meeting of the American Society of Mechanical Engineers in the Engineering Societies' Building, 29 W. 39th St., New York City.

DECEMBER 1-6—Third National Exposition of Power and Mechanical Engineering in the Grand Central Palace, New York City.

DECEMBER 8-13—Exposition of invention at the Engineering Societies' Building, 29 W. 39th St., New York City. General offices, 47 W. 34th St., New York City.

JANUARY 20-23—Annual meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

JANUARY 19-31—Southern Exposition at the Grand Central Palace, New York City. Further particulars can be obtained from the Southern Exposition, Greenville, S. C.

NEW BOOKS AND PAMPHLETS

TESTS OF SOME GIRDER HOOKS. By Herbert L. Whittemore and Ambrose H. Stang. 21 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 260 of the Bureau of Standards. Price, 10 cents.

OPERATION OF THREE-PHASE INDUCTION MOTORS UNDER ABNORMAL SUPPLY CONDITIONS. By D. D. Ewing and C. F. Bowman. 7 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Circular No. 4 of the Engineering Extension Service.

THEORY OF DETERMINATION OF ULTRA-RADIO FREQUENCIES BY STANDING WAVES ON WIRES. By August Hund. 54 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 491 of the Bureau of Standards.

A CHAPTER IN AMERICAN EDUCATION. By Ray Palmer Baker. 170 pages, 5 by 7¼ inches. Published by Charles Scribner's Sons, 597 Fifth Ave., New York City.

This book was written in commemoration of the hundredth anniversary of the foundation of Rensselaer Polytechnic Institute, which was established in 1824. The history of the institution is of general interest because of its influence in establishing educational facilities for women, developing agriculture as a science, providing for advanced and specialized research, and expediting the progress of science and technology.

POWER PLANT MACHINERY. By Walter H. James and Myron W. Dole. 267 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $3 net.

This is the second volume of a work on power plant machinery, the first of which dealt with the mechanism of steam engines. The present volume discusses details and accessories, and describes the construction of the various parts of reciprocating engines, treating of turbines in a more thorough manner than in the first volume. Compressors, pumps, steering engines, reversing gears, and steam and compressed air tools are described, and the various auxiliaries are treated, including feed water heaters, condensers, cooling towers, etc. The two volumes are intended to form a connecting link between the study of mechanism and heat engineering.

FREEHAND DRAFTING. By Anthony E. Zipprich. 131 pages, 6 by 9 inches; 71 illustrations. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $1.60.

This book consists of explanatory plates and problems in freehand mechanical drafting, which are the outcome of a number of years' experience in teaching and practicing the art. Freehand drafting is of especial value to those who do not find it convenient or who do not have the time to make drawings with instruments, and in consequence this book is designed for mechanics, salesmen, executives, and students in evening and trade schools. It includes about 170 problems and exercises, besides explanatory plates, arranged with a view to enabling the student to gain, in a minimum of time, ability to sketch industrial objects and acquire the fundamentals of mechanical drawing.

A. S. M. E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT. 758 pages, 8½ by 11½ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $5.

This is the fourteenth annual volume of this well-known catalogue and directory. The present edition shows a gain over the previous one, having a total of 527 pages of catalogue data carried by 430 firms. The mechanical equipment directory has also increased in comprehensiveness, now containing 3900 separate listings representing 4400 firms. One of the valuable features of the book is the professional engineering service directory, which contains a classified list of members of the American Society of Mechanical Engineers engaged in the various branches of professional engineering practice, together with condensed catalogue information describing the field and services of engineers in this field.

HENLEY'S TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS, AND PROCESSES. Edited by Gardner D. Hiscox. 800 pages, 6 by 9 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $4.

A new and enlarged edition of this useful book of recipes and formulas has been brought out. The present volume contains ten thousand different formulas and recipes applicable in the household, factory, office, and work-shop. The material has been thoroughly revised and some new matter has been added, as, for example, the chapter on laboratory methods. The book covers an amazingly wide range, from recipes for resilvering mirrors to formulas for making anti-freezing solutions for automobile radiators. The editor states in the preface that each recipe is to be regarded as a basis of experiment, to be modified to suit the particular purpose in hand. Some of the subjects treated are alloys, adhesives, aluminum, antidotes for poisons, disinfectants, cleaning preparations, dentifrices, dyes, hair tonics, rust preventives, paints, jewelers' formulas, leather, lubricants, photography, plating, solders, waterproofing, etc.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS. Over 4000 pages, 9 by 12 inches. Published by the Thomas Publishing Co., 461 Eighth Ave., New York City. Price, $15.

This is the fifteenth edition of this well-known reference guide for buyers, covering all lines of American manufactures. The new edition follows the same arrangement as previous ones. The largest section of the book, which covers 3443 pages and is printed on white paper, contains a list of the names and addresses of the manufacturers in all lines of industry in America, classified by products. The index or finding list is printed on yellow, which makes it easily distinguished from the other sections. In addition to the classified list of manufacturers, there is an alphabetical list of manufacturers printed on blue paper, which gives both home and branch offices, and a list of the leading trade names and brands of the products covered, printed on pink paper. The appendix contains a list of banks, boards of trade and other commercial organizations, and leading trade papers. Capital ratings are given with a view to differentiating between the small and large shops, and are not intended to indicate anything in respect to credit. The names listed are, in nearly all instances, manufacturers or producers. In some cases, however, it has seemed desirable to include secondary sources of supply, such as jobbers, and these are differentiated from the others by proper designations.

MANAGEMENT'S HANDBOOK. By L. P. Alford, Editor-in-Chief. 1610 pages, 4½ by 7¼ inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $7.50.

During recent years there has been an intensive development in the science of management. As a result there is now a body of classified management knowledge capable of general application. The present book has brought together this classified knowledge and practice for the benefit of managers and executives, consultants practicing in the field of management, and students. This is the first venture in this field, and for this reason will undoubtedly be received with great interest. The book follows closely in treatment and style regular engineering handbooks. The plan of the book divides the subject matter into three groups, material for each group having been collected by a specialist in the field to which it pertains. The first group, containing four sections, is devoted to general information of a fundamental character, including tables, statistics, charts, graphs, management ratios, and mathematics. The second group contains seventeen sections dealing with established management functions, methods, and mechanisms, such as plant layout, office management, design of forms, classifications, and symbols, purchasing and storekeeping, operation study, rate-setting, wage-payment plans, time-keeping methods, packing goods for shipment, etc. The third group of eleven sections covers the economic principles underlying industry, organization both for ownership and operation, budgetary control methods, cost accounting, banking and insurance, analysis of markets, maintenance of the labor force, and methods for classifying and filing management information.

NEW CATALOGUES AND CIRCULARS

SHAPER. Cincinnati Shaper Co., Elam St. and Garrard Ave., Cincinnati, Ohio. Catalogue descriptive of the new Cincinnati Climax shaper.

HACKSAW BLADES. Ronan Saw & Tool Works, Buffalo, N. Y. Circular giving dimensions and prices of hacksaw blades for hand frames and power machines.

HARDNESS TESTER. Wilson-Maeulen Co., Inc., 375 Concord Ave., New York City. Circular calling attention to demonstrations made with the Rockwell hardness tester.

POWER TRANSFORMERS. Wagner Electric Corporation, St. Louis, Mo. Bulletin 140, illustrating and describing different styles of power transformers made by this company.

COMPENSATER. Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1047, describing a new E. C. & M. automatic high-voltage compensater for alternating-current squirrel-cage motors.

FURNACE PERMEAMETER. Western Electric Co., Inc., 195 Broadway, New York City. Pamphlet containing a description of a furnace permeameter for alternating-current measurements at small magnetizing forces.

BABBITT. Ajax Metal Co., Philadelphia, Pa. Pamphlet entitled "Babbitt Facts," describing the different classes of babbitt produced by this concern, and giving suggestions for selecting the best babbitt for various purposes.

CHUCKS. Skinner Chuck Co., New Britain, Conn. Catalogue 38, covering the Skinner line of chucks for lathes, drills, and planers; face-plate jaws; and vises. Several new tools are listed, and new prices, effective October 1, are included.

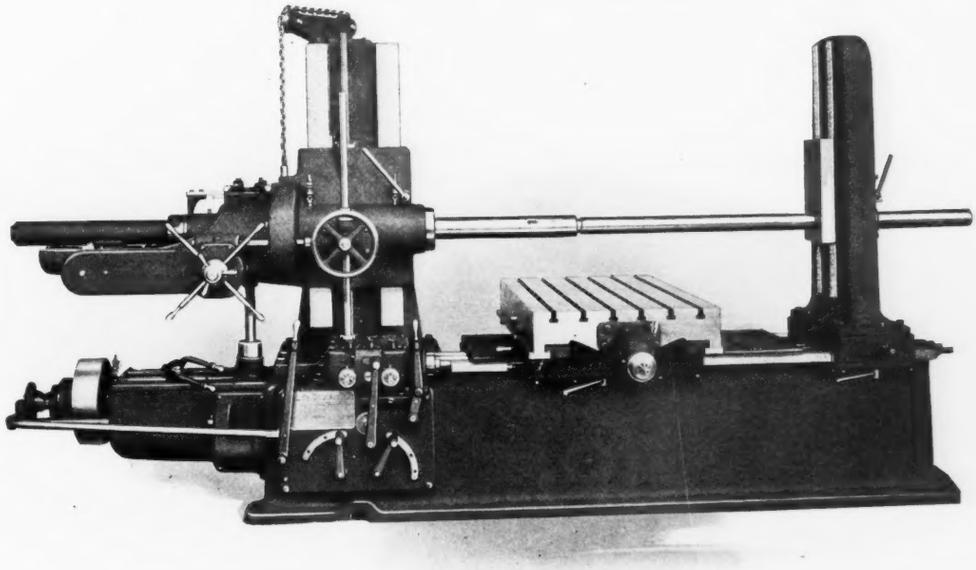
WELDING AND CUTTING APPARATUS. Burdett Service, St. Johns Court at Fulton St., Chicago, Ill. Catalogue illustrating the "Burco" line of welding and cutting products, including

"The nicest thing about PRAISE is that you have to LIVE UP TO IT"

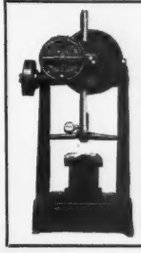
Therefore, every NEW user of the

"PRECISION"

Boring, Drilling and MILLING MACHINE



gets the benefit of the "other fellows" praise (and there are very many of the "other fellows").



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LUCAS POWER
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FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich, V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

oxy-acetylene and oxy-hydrogen torches and regulators.

GEAR DRIVES. Mesta Machine Co., Pittsburg, Pa. Bulletin B, illustrating a number of installations of Mesta double-helical cut-teeth gear drives. The bulletin also illustrates and describes the process of manufacture of Mesta gears.

LIGHTING. Cooper Hewitt Electric Co., 103 River St., Hoboken, N. J. Booklet entitled "Work Light," discussing the need of adequate light for workers, and showing various installations of Cooper Hewitt lights in industrial plants.

MOTORS. Triumph Electric Co., Cincinnati, Ohio. Bulletin outlining the operating advantages of the TR self-start motor, a constant-speed polyphase alternating-current motor, built in a complete range of sizes from 3 to 125 horsepower.

ANGULAR TRANSMISSION. G. M. Bartlett, 2533 College Ave., Indianapolis, Ind. Circular descriptive of the Bartlett angular transmission, which is designed for transmitting power between shafts that are located at an angle with each other.

FLEXIBLE COUPLINGS. Foote Bros. Gear & Machine Co., 232 N. Curtis St., Chicago, Ill. Bulletin descriptive of the different types of Foote Bros. IXL flexible couplings, and containing tabulated data of shaft sizes, dimensions, weights, and prices.

IRON AND STEEL. Oliver Bros., Inc., 71 Murray St., New York City, is distributing a table of current market values of iron, steel, wire and metal materials, covering the period from 1897 to 1924. Copies will be sent to those interested upon request.

SPEED REDUCERS. Horsburgh & Scott Co., 5114 Hamilton Ave., N.E., Cleveland, Ohio. Circular containing sepcifications covering the line of worm-gear speed reducers made by this company. Tables of horsepower ratings of standard units are included.

CENTRIFUGAL PUMPS. Earle Gear & Machine Co., 4707-15 Stenton Ave., Philadelphia, Pa. Catalogue descriptive of Earle centrifugal pumps which are made in single-stage single-suction, single-stage double-suction, and multi-stage single-suction types.

RESISTOR UNITS. General Electric Co., Schenectady, N. Y. Bulletin 48941A, describing the uses and advantages of CR-9006 enameled resistor units, and giving standard ratings and dimensions. Applications for several different fields of service are shown.

GOVERNORS. Duplex Engine Governor Co., Inc., 36 Flatbush Ave. Extension, Brooklyn, N. Y. Bulletin 102, containing a parts price list of "Simplex" precision governors for use on internal combustion engines using gasoline, illuminating gas, distillate, alcohol, etc.

STROBOSCOPES. Rotostat Instrument Co., 220 N. 13th St., Philadelphia, Pa. Booklet entitled "A Mechanical Eye for Machine Designers," describing the "Rotostat"—a machine for assisting in the observation of high-speed machinery—and its application to the industries.

HEAT-TREATING FURNACES. W. S. Rockwell Co., 50 Church St., New York City. Bulletin 261, showing installations and describing various applications of Rockwell automatic rotary furnaces and quenching, coating or coloring tanks for continuous heating, quenching, and processing.

DIE-CUTTING MACHINES. Keller Mechanical Engineering Corporation, 74 Washington St., Brooklyn, N. Y. Circular descriptive of Keller type F and type BG automatic machines for machining irregular contours and cavities in dies, patterns, core-boxes, jigs and fixtures, cams, etc.

ELECTRICAL FITTINGS. Crouse-Hinds Co., Syracuse, N. Y. Folder 17, illustrating the "Arktite" series of circuit-breaking plugs and receptacles, designed to prevent short circuits or grounds. Bulletin 2061, containing data of R. S. series and type AJX condulets with removable side plates.

MILLING MACHINES. Ingersoll Milling Machine Co., Rockford, Ill. Circular descriptive of the Ingersoll adjustable rotary milling machine, which has been developed for shops having a wide range of irregular shaped work, such as is found in railroad shops and die-sinking shops or tool-rooms.

GRINDING WHEELS. Norton Co., Worcester, Mass. Pamphlet entitled "Factors Affecting Grinding Wheel Selection," containing specific suggestions for selecting grinding wheels. A table of wheels recommended for different operations and classes of work is a valuable feature of the book.

SCREW MACHINES AND PRODUCTS. National Acme Co., Cleveland, Ohio. Calendar for November, 1924, to November, 1925, showing on each sheet, besides the calendar for three months, some of the products of the company, including turret lathes, automatic screw machines, screw machine products, taps, dies, etc.

PRESSES. Metalwood Mfg. Co., Detroit, Mich. Catalogue covering the complete line of hydraulic and hydro-pneumatic presses made by this concern. The catalogue contains illustrations and specifications for the different sizes and styles of presses, and includes tables of pressures, capacities, and speeds.

PRESSES. Baird Machine Co., Bridgeport, Conn. Bulletin of Baird presses, including blanking or dieing presses, foot presses, bench power presses, open-back presses, and tandem presses. The bulletin also contains specifications covering the Baird 6- by 6-inch six-spindle horizontal chucking machine.

STEELS. Crucible Steel Co. of America, 17 E. 42nd St., New York City. Booklet covering the latest developments in non-corrosive and heat-resisting steels, including stainless steel and stainless iron. Considerable technical information is given, which should be of use to those interested in this subject.

SAWS. Hunter Saw & Machine Co., Pittsburg, Pa. Circular illustrating and describing the No. 1 Hunter high-speed cut-off saw, designed for cutting cold metal, such as light-section beams, channels, angles, brass and copper tubing, metal furniture parts, light-section pressed and drawn steel shapes, etc.

METAL SPRAYING EQUIPMENT. Metals Coating Co. of America, 495 N. Third St., Philadelphia, Pa. Pamphlet descriptive of the Schoop process of metal spraying and the equipment used in connection with this process. Different applications of the process are illustrated, which are suggestive of its wide scope.

SPEED REDUCERS. Foote Bros. Gear & Machine Co., 232 N. Curtis St., Chicago, Ill. Catalogue 25, covering Foote Bros. IXL spur-gear and worm-gear speed reducers. An explanation is given of the different types, and the various applications and uses are illustrated. Tables of dimensions, prices, etc., are included.

COUNTERBORING SETS. Gairing Tool Co., Inc., Detroit, Mich. Circular illustrating the counterboring sets made by this concern, which include a holder and interchangeable core drills, spot facers, countersinks, counterbores, etc. The illustrations show clearly the type of work for which each tool is adapted.

TRUCKS, BOXES, AND BENCH TOPS. R. G. Haskins Co., 518½ W. Monroe St., Chicago, Ill. Catalogue 24, illustrating and describing the products of the company, including panels, trucks, boxes, and bench tops made from a material called "metalwood," which, as its name implies, is a combination of metal and wood.

ELECTRIC SCREWDRIVER. Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 605, descriptive of the new Hisey friction-head screwdriver, an electrically driven portable tool equipped with a disk type friction clutch, which is automatically regulated by the pressure applied so as to give the operator full control at all times.

BORING TOOLS AND REAMERS. Davis Boring Tool Co., Inc., St. Louis, Mo. Catalogue 24, covering Davis expansion boring tools and reamers for industrial and automobile manufacturing plants. The stock sizes of these tools are listed, and information is given as to which styles of tools are best adapted for different classes of machines.

WELDING ELECTRODES. General Electric Co., Schenectady, N. Y. Booklet Y-2019, describing the new type A General Electric welding electrode. Results of tests on welded cast-iron specimens and deposited metal specimens are described. The pamphlet also includes instructions for using the electrode, and specifications of the standard sizes.

HOISTS. Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Illustrated descriptive price list and catalogue of floor-operated electric hoists, describing the various types of hoists made by this company and showing a number of different installations. Clearance drawings and complete information regarding capacities, heights of lifts, prices, etc., are included.

SCREW CUTTING TOOLS. Geometric Tool Co., New Haven, Conn., is distributing a monthly publication known as "Threads," which is devoted to matters relative to screw-thread cutting, and also contains information on the screw-cutting tools made by this concern, including adjustable die-heads, taps, threading machines, tapping devices, chucks and collets, etc.

MILLING MACHINES. Cincinnati Milling Machine Co., Cincinnati, Ohio. Catalogue entitled "Service that Saves," illustrating milling operations performed in the plants of over fifty manufacturers both in this country and abroad. These jobs illustrate the complete line of thirty-eight types and sizes of milling machines made by this concern. Copies may be obtained by those interested upon request.

LATHES. R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Booklet entitled "Critical Analysis of a Heavy-duty Lathe." This book is unique in that the entire text is arranged in the form of questions and answers, the questions being those that a careful engineering buyer would ask. In this way the important features of construction of LeBlond heavy-duty lathes are clearly brought out.

DIRECTORY. British Engineers' Association, Inc., 32 Victoria St., Westminster, London, S.W. 1, England. 1924 directory of British manufacturers in the engineering field and their products, containing the names, addresses, telegraph addresses, codes, and full details concerning manufacturers in this field. An alphabetical list of the manufacturers is included. Those who are interested can obtain copies from the secretary of the association.

PRECISION LOCATING AND JIG DRILLING AND BORING MACHINES. Societe Genevoise d'Instruments de Physique, Geneva, Switzerland (R. Y. Ferner Co., Investment Bldg., Washington, D. C., United States representative). Catalogues illustrating and describing, in English, the model No. 1 high-precision locating and jig drilling machine and the models Nos. 2, 4, and 5 high-precision locating and jig boring machines made by this company.

ELECTRIC STEEL CASTINGS. A new publication known as the *Research Group News*, is being issued by the Electric Steel Founders' Research Group, which is composed of the Fort Pitt Steel Casting Co., McKeesport, Pa., Lebanon Steel Foundry, Lebanon, Pa., Michigan Steel Casting Co., Detroit, Mich., Nugent Steel Castings Co., Chicago, Ill., and the Sivyer Steel Casting Co., Milwaukee, Wis. The purpose of the publication is to supply users of metal parts with information concerning electric steel castings, based on experiments and scientific investigation. The research director is R. A. Bull, 541 Diversey Parkway, Chicago, Ill.